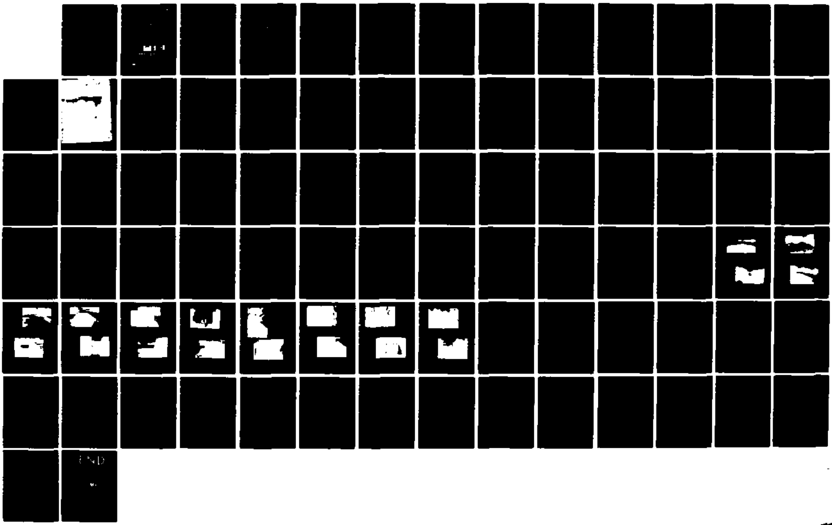
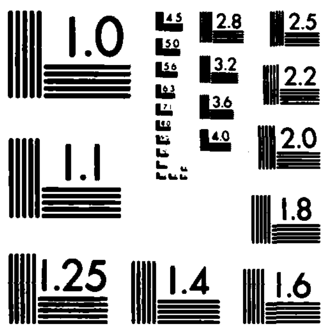
AD-A156 363 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS CRYSTAL LAKE DAM (NH) (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV NOV 78 1/1

UNCLASSIFIED F/G 13/13 NL




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

[illegible]

[illegible], NEW HAMPSHIRE



# CRYSTAL LAKE DAM

## NH 00018

NHWRB NO. 91.11

# PHASE I INSPECTION REPORT
# NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. [illegible]

NOVEMBER, [illegible]

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>NH 00018 | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>Crystal Lake Dam<br>NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS | | 5. TYPE OF REPORT & PERIOD COVERED<br>INSPECTION REPORT |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>U.S. ARMY CORPS OF ENGINEERS<br>NEW ENGLAND DIVISION | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>DEPT. OF THE ARMY, CORPS OF ENGINEERS<br>NEW ENGLAND DIVISION, NEDED<br>424 TRAPELO ROAD, WALTHAM, MA. 02254 | | 12. REPORT DATE<br>November 1978<br>13. NUMBER OF PAGES<br>75 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED<br>15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Gilmanton, New Hampshire
Suncook River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 188 ft. long, 16 ft. high earth embankment dam. The condition is fair. The visual inspection did not disclose any immediate safety problems. The dam's spillway will not pass the test flood, therefore it is recommended that the owner engage a qualified engineer to evaluate further the potential for overtopping the inadequacy of the spillway.

# DISCLAIMER NOTICE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

JAN 15 19[illegible]

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding to you a copy of the Crystal Lake Dam-Gilmanton Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, the New Hampshire Water Resources Board, State of New Hampshire, Concord, New Hampshire 03301, ATTN: Mr. George M. McGee, Sr., Chairman.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from he date of this letter.

I wish to take this opportunity to thank you and the Water Resc ces Board for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

CRYSTAL LAKE DAM

NH 00018

NHWRB 91.11

MERRIMACK RIVER BASIN
GILMANTON, NEW HAMPSHIRE

**PHASE I INSPECTION REPORT**
**NATIONAL DAM INSPECTION PROGRAM**

A-1

LETTER OF TRANSMITTAL

FROM THE CORPS OF ENGINEERS TO THE STATE

TO BE SUPPLIED BY THE CORPS OF ENGINEERS

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.: 00018

Name of Dam: Crystal Lake Dam

Town: Gilmanton

County and State: Belknap, New Hampshire

Stream: Suncook River

Date of Inspection: September 13, 1978

Crystal Lake Dam is a 188 foot long, 16 foot high earth embankment dam. Engineering data available consisted of a set of plans dated 1958 showing additions and improvements made to the existing dam as well as some earlier design sketch plans. No construction data or design calculations were available.

The visual inspection did not disclose any immediate safety problems. The condition of the dam is generally fair. The inspection revealed that the downstream embankment slope next to the left highway abutment is not adequately protected against erosion from the spring and surface water runoff and that trees and brush were growing on the upstream and downstream slopes. Also, visual inspection revealed a spring through a stone wall against the right highway bridge abutment, deterioration of the concrete retaining walls and obstructions in the downstream channel.

Crystal Lake Dam's spillway will not pass the required test flood. The dam's spillway capacity is approximately 21 percent of the test flood and consequently, the dam would be overtopped by approximately 5.2 feet under test flood conditions.

It is recommended that the owner engage a qualified engineer to evaluate further the potential for overtopping and the inadequacy of the spillway. Also, provisions should be made by the owner to clear all trees and brush from the upstream and downstream slopes, observe springs on the downstream slope next to the left and right highway bridge abutments once a month for one year and weekly during rising lake levels, make provisions for protecting the downstream slope next to the left highway bridge abutment and removing fallen trees from the downstream channel.

The recommendation and remedial measures are described in Section 7 and should be addressed within one year after receipt of this Phase I - Inspection Report by the owner.

Gordon H. Slaney, Jr.

Gordon H. Slaney, Jr., P.E.
Project Engineer

Howard, Needles, Tammen & Bergendoff
Boston, Massachusetts

This Phase I Inspection Report on Crystal Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Richard F. Doherty

RICHARD F. DOHERTY, MEMBER
Water Control Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there by any chance that unsafe conditions be detected.

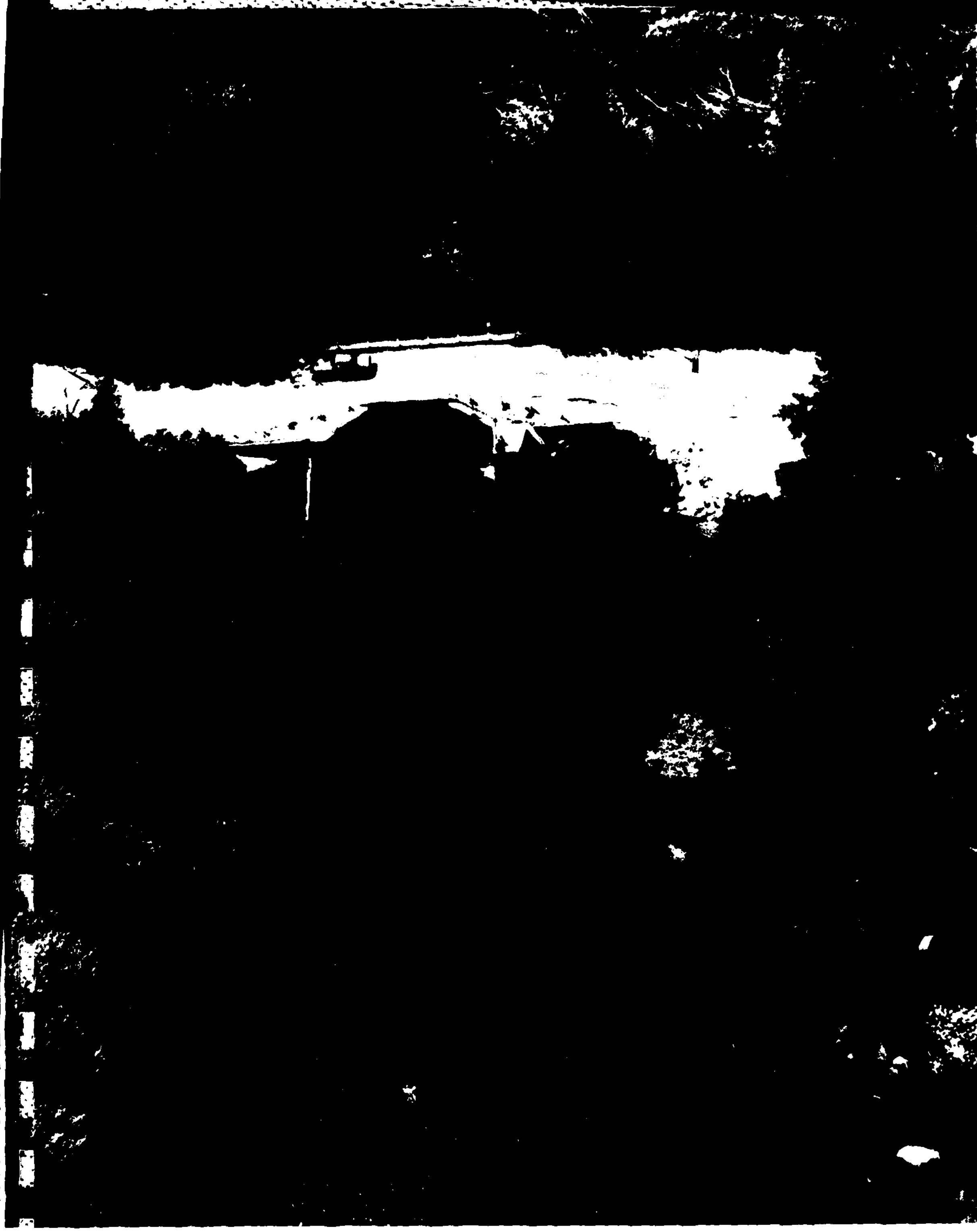
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

## TABLE OF CONTENTS

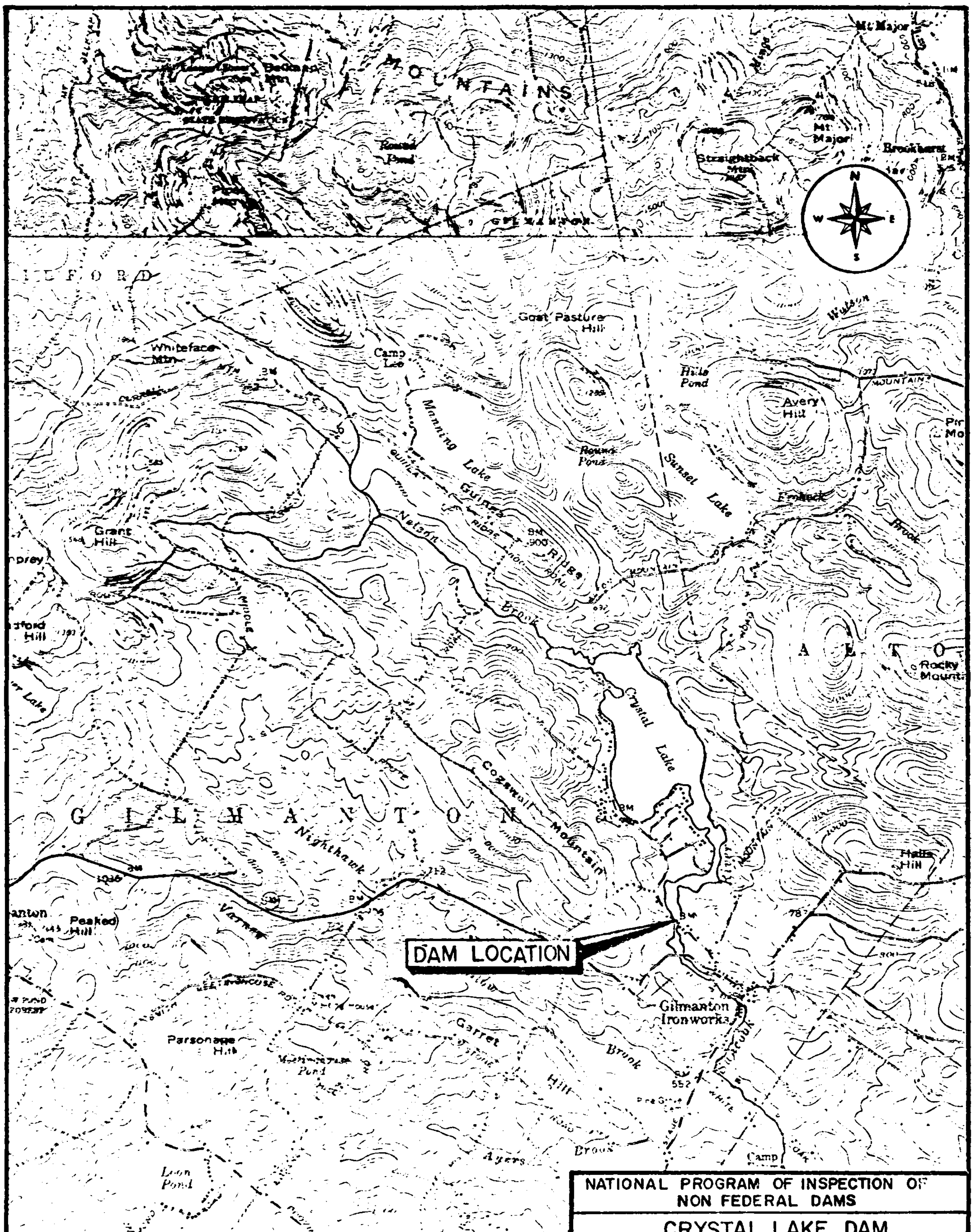


REPORT

APPENDIXES



CRYSTAL LAKE DAM - Overview looking downstream




NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS

CRYSTAL LAKE DAM

LOCATION PLAN

Gilmanton, New Hampshire
USGS Quad.—Suncook, N.H.

Scale: 1:62,500

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
CRYSTAL LAKE DAM

SECTION 1
PROJECT INFORMATION

## 1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Howard, Needles, Tammen & Bergendoff has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Howard, Needles, Tammen & Bergendoff under a letter of July 12, 1978 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0356 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

## 1.2 Description of Project

a. Location. Crystal Lake Dam is located in the Town of Gilmanton, New Hampshire, on the upper reach of the Suncook River. The Suncook River flows in a generally southerly direction for a distance of approximately 28 miles to its confluence with the Merrimack River in Suncook New Hampshire. The dam is shown on U.S.G.S. Quadrangle Gilmanton, New Hampshire, with coordinates approximately N 43°25'30", W 71°18'20" Belknap County, New Hampshire. Crystal Lake Dam's location is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Crystal Lake Dam is an earth embankment structure with a concrete spillway located about halfway between the left and right abutment. The upstream face of the dam consists of a concrete retaining wall extending approximately 86 feet to the left of the spillway structure and 43 feet to the right of the spillway structure. Details of this wall, except for its thickness, which is 9 inches, are not known. The downstream face of the dam consists of vertical wingwalls which also form part of a concrete roadway bridge, vertical stone walls and an earth fill section sloping two feet horizontal to one foot vertical. The structure is approximately 188 feet in length. The maximum structural height of the dam, according to existing plans, is about 16 feet.

The appurtenant structures consist of a pentagonal concrete spillway, spillway channel and an outlet works consisting of sluiceway with stoplogs. The outlet works stoplogs extend down to the original Suncook River bed. Figure 1, located in Appendix B, shows a plan of the dam and its appurtenant structures. Photographs of each structure are shown in Appendix C.

c. Size Classification. Intermediate (hydraulic height - 12 feet, storage 3,500 acre-feet) based on storage (≥1,000 to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dam's potential for damage rates it as a significant hazard classification. A major breach could result in the loss of a few lives and damage to approximately 7 or 8 houses and/or camps between the dam and Upper Suncook Lake.

e. Ownership. This dam is owned by the State of New Hampshire Water Resources Board.

f. Operator. This dam is maintained and operated by the State of New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301. Chairman of the Water Resources Board is Mr. George M. McGee, Sr.; Mr. Vernon Knowlton is Chief Engineer. Telephone No. (603)271-1110.

g. Purpose of Dam. The purpose of this dam is primarily to provide a recreational lake with some flood control benefits which are described in Section 4, Operational Procedures.

h. Design and Construction History. Little information is available regarding the original design and construction of Crystal Lake Dam. A set of drawings (2 sheets) was

prepared by the New Hampshire Water Resources Board in 1958 for the construction of the present spillway and stoplog sluiceway.

The drawings for this dam are available at the New Hampshire Water Resources Board. No in-depth design or construction data were disclosed for this dam.

i. Normal Operational Procedure. Crystal Lake Dam is used primarily for the retention of Crystal Lake which is used for recreational purposes. A secondary purpose of the dam and its resulting reservoir area is for control of winter and early spring runoff. The normal operational procedure for this dam is to remove the stoplogs in the sluiceway sometime in the month of October or November of each year thus lowering the reservoir level approximately 3 feet. The resultant available storage is used to control snow melt and heavy runoff during the winter and spring months. In May of each year, the stoplogs are then reinserted into the sluiceway, thus returning the reservoir level to its summertime recreational level. Every fifth year the reservoir is lowered 5 feet instead of the normal 3 feet.

## 1.3 Pertinent Data

a. Drainage Area. The drainage area above the Crystal Lake Dam consists of approximately 27 square miles of rolling, heavily wooded hills. The periphery of Crystal Lake is comprised of wooded area with some residences located near the reservoir.

The reservoir area itself contains no islands and is devoid of dead trees protruding through the surface or other visible impediments to navigation. There were some private docks or piers noted along the area inspected.

The watershed supporting Crystal Lake is forested rolling terrain with very few flat areas. All areas in the basin are well vegetated with manmade imperviousness being limited to a few paved roads and housing. Topographic elevation in the watershed ranges from about 1,700 to 620 feet MSL.

There are few relatively small tributaries which drain into the lake. The longest of these tributaries is approximately 3.0 miles long with a vertical drop over its length of about 300 feet.

b. Discharge at Dam Site

(1) The outlet works for the Crystal Lake Dam consists of a 6 foot wide sluiceway. The reservoir behind the dam can

be lowered 6.5 feet below the spillway crest elevation (623.3) by the removal of the wooden stoplogs in the sluiceway. Removal of all stoplogs will lower the reservoir level to the original river bed elevation of 616.8.

(2) This dam was subjected to the storm of 1938 without damage. Maximum discharge at this dam site is, however, unknown.

(3) The spillway capacity with a water surface at the top of the dam and assuming stoplogs in sluiceway set at the same elevation as the permanent spillway crest is approximately 2,450 cfs at an elevation of 629.0.

(4) The spillway capacity with the water surface at the test flood elevation, again assuming the stoplogs in the sluiceway are set at the same elevation as the permanent spillway crest is approximately 4,500 cfs at an elevation of approximately 634.2.

(5) The total project discharge at the test flood elevation of 634.2 is estimated to be 11,910 cfs.

c. Elevation (feet above MSL) based on elevation of 628.0 shown on U.S.G.S. quad sheet assumed to be top of concrete portion of dam (disc located in field).

(1) Streambed at centerline of dam - 616.8.

(2) Maximum tailwater - unknown.

(3) Upstream portal invert diversion tunnel - none.

(4) Recreation pool - 623.3.

(5) Full flood control pool (see Section 1.2.i) - 620.3.

(6) Spillway crest (permanent spillway) - 623.3.

(7) Design surcharge - unknown.

(8) Top dam - 629.0.

(9) Test flood surcharge - 634.2.

d. Reservoir (miles)

(1) Length of maximum pool - 2.3+.

(2) Length of recreation pool - 2.3.

(3) Length of flood control pool - 2.2.

e. Storage (acre-feet)

(1) Recreation pool - 1,400.

(2) Flood control pool - 100±.

(3) Spillway crest pool - 1,400.

(4) Top of dam - 3,500.

(5) Test flood pool - 6,250.

f. Reservoir Surface (acres)

(1) Recreation pool - 441.

(2) Flood control pool - 441. Note: Vertical sides assumed.

(3) Spillway crest - 441.

(4) Test flood pool - 441.

(5) Top dam - 441.

g. Dam

(1) Type - stone, earth, concrete.

(2) Length - 188 feet, overall.

(3) Height - 16 feet (maximum).

(4) Top width - 35± feet.

(5) Side slopes - US = Vertical, DS = Variable.

(6) Zoning - unknown.

(7) Impervious core - concrete upstream wall.

(8) Cutoff - 7 foot concrete.

(9) Grout curtain - none.

(10) Other - none.

h. Diversion and Regulating Tunnel

See Section j below.

i. Spillway

(1) Type - concrete, pentagonal with straight drop.

(2) Length of weir - 115.5.

(3) Crest elevation - 623.3.

(4) Gates - stoplog sluiceway - 6 feet wide.

(5) U/S channel - none.

(6) Downstream channel - a 13 foot reach approximately 30 feet wide downstream of the spillway leads to a roadway bridge about 21 feet wide. Below the bridge the downstream channel consists of a natural, rock bottom streambed with only few overhanging trees.

j. Regulating Outlets. Regulating outlet consists of a 6 foot wide stoplog sluiceway which was designed to lower the reservoir to the original river bed elevation (616.8) by the removal of all stoplogs.

## SECTION 2
## ENGINEERING DATA

### 2.1 Design

No original design data were disclosed for Crystal Lake. A set of drawings (2 sheets) dated 1958 showing additions and improvements made to the existing dam as well as some earlier design sketch plans were found. No in-depth engineering calculations were found.

### 2.2 Construction

No construction records were available for use in evaluating the dam.

### 2.3 Operation

No engineering operational data were disclosed.

### 2.4 Evaluation

a. Availability. Little engineering data were available for Crystal Lake Dam. A search of the files of the New Hampshire Water Resources Board revealed only a limited amount of recorded information.

b. Adequacy. Because of the limited amount of detailed data available, the final assessment and recommendations of this investigation are based on visual inspection and hydrologic and hydraulic calculations.

c. Validity. The field investigation indicated that the external features of Crystal Lake Dam substantially agree with those shown on the available plans.

## SECTION 3
## VISUAL INSPECTION

### 3.1 Findings

a. General. The field inspection of Crystal Lake Dam was made on September 13, 1978. The inspection team consisted of personnel from Howard, Needles, Tammen & Bergendoff and Geotechnical Engineers, Inc. A representative of the State of New Hampshire Water Resources Board was also present during portions of the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of the inspection, the water level was approximately 2½ inches below the permanent spillway elevation. No water was passing over the spillway. The upstream face of the dam could only be inspected above this water level.

b. Dam. There is an earth embankment with a concrete spillway located about halfway between the left and right abutments. The spillway structure also serves as the outlet channel. The boundaries between the earth embankment and the left and right abutments are indistinct.

Visual inspection of the earth embankment and the abutments showed no signs of immediate distress.

Upstream Slope

The upstream slope above pool elevation contains small trees and brush.

Crest

The asphalt pavement on the crest of the dam contains surficial cracks typical of asphalt pavements in general. The asphalt pavement condition gives no indication of movement of the embankment.

Downstream Slope

The downstream slope has been allowed to become overgrown with dense vegetation including trees up to about 10 inch in diameter. Photo 16 shows the dense vegetation on the downstream slope as viewed from the left abutment area, and Photo 17 shows the same slope as viewed from the embankment crest. Vegetation on the right downstream slope as viewed from the right abutment area can be seen in Photo 15 which also shows a stone wall on the slope running

approximately parallel with the embankment crest. The stone wall may have formed part of a pre-existing dam at the site.

Two springs were found on the downstream slope of the embankment, one through a stone wall against the right highway bridge abutment and the other through riprap on the slope next to the left highway abutment.

The spring from the riprap on the left highway abutment can be seen in Photo 14. Water from this spring flows into the discharge channel and no siltation was visible in the spring area. The spring was observed exiting the riprap at an elevation of about 618 MSL (USGS Benchmark = 628.0 MSL), or about 5 feet below lake level. The exit point(s) of the spring beneath the riprap could not be located. Continued flow of the spring water over the unprotected slope may cause serious erosion of the slope, especially during high levels. Surface water runoff down the slope has caused erosion beneath the riprap.

The spring from the stone wall at the right highway abutment can be seen in Photo 13 which shows that the majority of water flows from under the lowest visible stone next to the highway abutment. This spring is about 15 feet from the discharge channel. The spring water flows first to a grassy area and then into the discharge channel. A sample of water from this spring did not appear silty and silt was not visible in the grassy area downstream of the spring. The spring elevation was estimated to be about 615 MSL (USGS Benchmark = 628.0 MSL) or about 8 feet below lake level.

The springs on the downstream slope of the embankment do not pose an immediate hazard to the dam.

c. Appurtenant Structures. Visual inspection of the concrete spillway structure, sluiceway structure and spillway channel with its structural components did not reveal any evidence of stability problems. The concrete surface appeared to be in generally good condition. The concrete portions of the highway bridge, however, showed some signs of deterioration in the form of cracks, staining and probably subsurface delamination.

The spillway structure (Photo 6) consists of a gravity concrete wall placed over a 9 inch concrete apron slab with a 7.0 foot cutoff wall. The spillway structure is in good condition as shown in Photo 10.

The outlet works consist of a sluiceway (photo 9) formed by two vertical concrete walls with removable wooden stoplogs.

The top of the sluiceway structure is covered with a concrete deck. The maximum effective sluiceway opening is 6.0 feet wide by 9.5 feet high. The sluiceway structure including the concrete surface and construction joints appear to be in good condition.

The spillway channel consists of a rectangular (22.3 x 11.0) concrete box structure and four massive retaining walls. The two retaining walls on the upstream face of the dam are incorporated into the spillway structure (Photo 8, 11 and 18). Visual inspection of the retaining walls indicated that the concrete has deteriorated since original construction. Numerous cracks and staining are visible on all walls. Subsurface concrete delamination also appears to be present with corrosion of reinforcing steel being possible. A large portion of the concrete deterioration may be attributed to the effects of de-icing agents, normal weathering and complete lack of drainage facilities. An asphaltic concrete pavement contains surficial cracks and the curb detail is such that it does not prevent water from penetrating around the concrete box structure.

d. Reservoir Area. The reservoir slopes are generally covered with trees and brush. A more detailed description of the drainage area is included in Section 1.3 of this report. Cottages are scattered along the shoreline. The amount of siltation within the reservoir is unknown.

e. Downstream Channel. The downstream channel is heavily covered with rocks and shows some signs of streambed deposits of gravel. Trees overhang the downstream channel but pose no immediate hazard to the dam. Several hundred feet downstream there are some fallen trees in the channel. The downstream channel passes through a small developed portion of Gilmanton prior to discharging into Upper Suncook Lake.

## 3.2 Evaluation

Visual examination did not disclose any immediate safety problems. The condition of the dam is generally fair. The inspection revealed the following:

(a) The downstream embankment slope next to the left highway abutment is not adequately protected against erosion from the spring and surface water runoff.

(b) Tree and brush growth on the upstream and downstream slopes.

(c) A spring through a stone wall against the right highway bridge abutment.

(d) Deterioration of the concrete retaining walls.

(e) Downstream channel obstruction caused by fallen trees.

## SECTION 4
## OPERATIONAL PROCEDURES

### 4.1 Procedure

The Crystal Lake Dam is used primarily for the retention of Crystal Lake which is used for recreational purposes. A secondary purpose of the dam and its resulting reservoir area is for control of winter and early spring runoff. The normal operational procedure for this dam is to remove the stoplogs in the sluiceway sometime in the month of October or November of each year thus lowering the reservoir level approximately 3 feet. The resultant available storage is used to control snow melt and heavy runoff during the winter and spring months. In May of each year, the stoplogs are then reinserted into the sluiceway, thus returning the reservoir level to its summertime recreational level.

### 4.2 Maintenance of Dam

This dam is visited by one of the State of New Hampshire Water Resources Board's dam operators approximately once per week. During these visits water levels are recorded, grass is cut as necessary, painting is done as necessary and any major deficiencies that may be noted are reported to the Water Resources Board. Occasional clearing of the brush on the embankment is also scheduled on a need basis.

In 1959, a new spillway and stoplog sluiceway were constructed with the stoplogs being used to control the lake level.

### 4.3 Maintenance of Operating Facilities

Maintenance on the outlet works facilities is done on an as needed basis.

### 4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

### 4.5 Evaluation

The current operation and maintenance procedures for Crystal Lake Dam are inadequate to insure that all problems encountered can be remedied within a reasonable period of

time. The owner should establish a written operation and maintenance procedure as well as establishing a warning system to follow in event of flood flow conditions or imminent dam failure.

## SECTION 5
## HYDROLOGY AND HYDRAULIC ANALYSIS

### 5.1 Evaluation of Features

a. General. Crystal Lake Dam is an earth embankment structure with a total length of approximately 188 feet and a maximum structural height of 16 feet. The appurtenant works consist of an 115 foot concrete spillway and a 6 foot wide stoplog sluiceway section. The dam is located on the Suncook River and creates an impoundment of water primarily used for recreational purposes. By lowering the reservoir level during the winter, the storage created behind the dam is also used to provide some control over snow melt and stormwater runoff during the winter months. Crystal Lake Dam is classified as being intermediate in size having a maximum storage of 3,500 acre-feet.

b. Design Data. No hydrologic or hydraulic design data were disclosed for Crystal Lake Dam.

c. Experience Data. This dam was subjected to the storm of 1938 without damage. Maximum discharge at this dam site is, however, unknown.

d. Visual Observations. No evidence of damage to any portion of the project from overtopping was visible at the time of the inspection.

e. Overtopping Potential. As no detailed design and operational information are available, hydrologic evaluation was performed using dam information gathered by field inspection, watershed size and an estimated test flood equal to one-half the Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 27 square miles, it was estimated that the test flood inflow at Crystal Lake Dam would be 18,500 cfs. Following the guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharge results in a test flood discharge of 11,910 cfs. As the maximum spillway capacity at the top of the dam is only 2,450 cfs (approximately 21 percent of the test flood discharge flow), the test flood will result in the dam being overtopped by approximately 5.2 feet.

f. Dam Failure Analysis. The impact of failure of the dam at maximum pool was assessed using the "Rule of the Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs

issued by the Corps of Engineers. The analysis covered the reach extending from the dam to Upper Suncook Lake approximately 2½ miles downstream. Failure of Crystal Lake Dam at maximum pool would probably result in an increase in downstream channel depth of about 6 feet. An increase in water depth of this magnitude would probably result in the loss of a few lives. Property damage would probably include 7 or 8 houses and/or camps along Stage Road and the shores of Upper Suncook Lake, particularly in the swampy area immediately to the north of this Lake. In addition, the two roadways between Crystal Lake and Upper Suncook Lake would probably be damaged.

## SECTION 6
## STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

a. Visual Observations. The visual inspection did not disclose any apparent stability problems.

b. Design and Construction Data. Design drawings and correspondence made available for this inspection indicate that the overall dam length is 188 feet. A cutoff wall extends to the right and left of the concrete highway bridge structure. The cutoff wall consists of reinforced concrete over wood sheet piling; the relative depths of the concrete and wooden portions were not indicated by the available data.

Design and construction data on the earth embankment were not available.

c. Operating Records. Review of dam inspection reports indicate that from its reconstruction in 1929 to 1953 the dam was in good to excellent condition. A 1953 inspection report indicated that the flashboards were partially failed and that repairs were needed. The dam was partially reconstructed in 1959; inspection reports after 1959 were not disclosed.

d. Post-Construction Changes. Available information indicates that the original dam was built before 1860. The dam was reconstructed in 1929, the following changes being made: (1) Increase in spillway capacity and (2) Installation of concrete wall over existing wooden sheet piling.

A second reconstruction was made in 1959, the major changes being the enlargement of the spillway section and the addition of a sluiceway.

e. Seismic Stability. The dam is located in Seismic Zone 2, and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

## SECTION 7
## ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

### 7.1 Dam Assessment

a. Condition. The visual inspection did not disclose any findings that indicate an immediate unsafe condition. The condition of the dam is generally fair. The inspection revealed the following:

(1) The downstream embankment slope next to the left highway abutment is not adequately protected against erosion from the spring and surface water runoff.

(2) Tree and brush growth on the upstream and downstream slopes.

(3) A spring through a stone wall against the right highway bridge abutment.

(4) Deterioration of the concrete retaining walls.

(5) Downstream channel obstruction caused by fallen trees.

The hydraulic analysis reveals that the dam cannot pass the required test flood.

b. Adequacy of Information. The information made available is such that the assessment of the safety of the dam must be based primarily on the visual inspection and the past performance of the structure.

c. Urgency. This dam is in generally fair condition. The recommendations and remedial measures described in 7.2 and 7.3 should be accomplished within 1 year after receipt of this Phase I Inspection Report by the owner.

d. Need for Additional Investigation. The findings of the visual inspection do not warrant additional investigation.

### 7.2 Recommendations

It is recommended that the owner engage a qualified engineer to evaluate further the potential for overtopping and the inadequacy of the spillway.

### 7.3 Remedial Measures

(a) Clear all trees and brush from the upstream and downstream slopes of the embankment and plant appropriate cover on the slopes to prevent erosion.

(b) Observe springs on the downstream slope next to the left and right highway bridge abutments once a month for one year and weekly during rising lake levels. Observations of the quantity and turbidity of spring water and any erosion caused by the spring water should be made. The need for further treatment of these springs should be determined after this period of observation.

(c) Make provisions for protecting the downstream slope next to the left highway bridge abutment from erosion caused by surface water runoff and spring water.

(d) Remove the fallen trees in the downstream channel and keep clear in the future.

(e) Develop a written operational procedure to follow in the event of flood flow conditions or imminent dam failure.

(f) Continue the technical inspection program on a semi-annual basis.

## 7.4 Alternatives

There are no practical alternatives to the recommendations in Sections 7.2 and 7.3 except that in an interim basis the owner may consider operating the reservoir at a lower level throughout the year so as to provide more storage for extreme flood events.

# APPENDIX A

# VISUAL CHECK LIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Crystal Lake - Gilmington

Assume USGS Benchmark = 628'

DATE September 13, 1978

TIME 10 A.M.

WEATHER Sunny - $60^0$

W.S. ELEV 623.0 U.S. 617.0 DN.S

Water is 2½" below new spillway

PARTY:

1. Gordon Slaney - HNTB
2. Stan Mazur - HNTB
3. Pat Kesaran - NH Water Resources Board
4. Dan LaGatta - GEI
5. Tom Keller - GEI
6. 
7. 
8. 
9. 
10. 

| PROJECT FEATURE | INSPECTED BY | REMARKS |
|---|---|---|
| 1. Dam | D. LaGatta, T. Keller | |
| 2. Spillway, Sluiceway | S. Mazur, G. Slaney | |
| 3. Downstream Channel | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |

## PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE Septemer 13, 1978

PROJECT FEATURE Dam

NAME T. O. Keller

DISCIPLINE Geotechnical Engineer

NAME D. P. LaGatta

| AREA EVALUATED | CONDITION |
| --- | --- |
| DAM EMBANKMENT | |
| Crest Elevation | 629.0 |
| Current Pool Elevation | 623.0 |
| Maximum Impoundment to Date | Unknown. |
| Surface Cracks | Asphalt pavement contains surficial cracks typical of asphalt pavement; these cracks cannot be traced to misalignment of dam. |
| Pavement Condition | Good. |
| Movement or Settlement of Crest | Crest is highway which appears to have undergone no significant movement. |
| Lateral Movement | None observed. |
| Vertical Alignment | No misalignment observed. |
| Horizontal Alignment | No misalignment observed. |
| Condition at Abutment and at Concrete Structures | Good condition. Some small trees and brush on upstream and downstream slopes. |
| Indications of Movement of Structural Items on Slopes | None. |
| Trespassing on Slopes | None observed. |
| Sloughing or Erosion of Slopes or Abutments | Surface erosion on downstream slope next to left highway bridge abutment. |
| Rock Slope Protection - Riprap Failures | None. |
| Unusual Movement or Cracking at or near Toes | None seen. |
| Unusual Embankment or Downstream Seepage | Springs observed through stone wall and riprap against downstream abutment walls of highway (see text). |
| Piping or Boils | None observed. |
| Foundation Drainage Features | None observed. |
| Toe Drains | None observed. |
| Instrumentation System | None. |
| Vegetation | Extensive trees and brush. |

PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Intake Channel/Structure

NAME T. O. Keller, D. P. LaGatta

DISCIPLINE Structural/Hydraulic/Geotechnical Engingeers

NAME S. Mazur, G. Slaney

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE | |
| a. Approach Channel | This facility has no approach channel. |
| Slope Conditions | |
| Bottom Conditions | |
| Rock Slides or Falls | |
| Log Boom | |
| Debris | |
| Condition of Concrete Lining | |
| Drains or Weep Holes | |
| b. Intake Structure | |
| Condition of Concrete | Good. |
| Stop Logs and Slots | Good. |

PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Control Tower

NAME

DISCIPLINE Structural Engineer

NAME S. Mazur

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - CONTROL TOWER | |
| a. Concrete and Structural | This facility has no tower. |
| General Condition | |
| Condition of Joints | |
| Spalling | |
| Visible Reinforcing | |
| Rusting or Staining of Concrete | |
| Any Seepage or Efflorescence | |
| Joint Alignment | |
| Unusual Seepage or Leaks in Gate Chamber | |
| Cracks | |
| Rusting or Corrosion of Steel | |
| b. Mechanical and Electrical | |
| Air Vents | |
| Float Wells | |
| Crane Hoist | |
| Elevator | |
| Hydraulic System | |
| Service Gates | |
| Emergency Gates | |
| Lightning Protection System | |
| Emergency Power System | |
| Wiring and Lighting System | |

PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Transition and Conduit

NAME

DISCIPLINE

NAME

| AREA EVALUATED | CONDITION |
| --- | --- |
| OUTLET WORKS - TRANSITION AND CONDUIT | |
| General Condition of Concrete | None. |
| Rust or Staining on Concrete | |
| Spalling | |
| Erosion or Cavitation | |
| Cracking | |
| Alignment of Monoliths | |
| Alignment of Joints | |
| Numbering of Monoliths | |

## PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Outlet Structure/Channel

NAME T. O. Keller, D. P. LaGatta

DISCIPLINE Structural/Hydraulic/Geotechnical Engineers

NAME S. Mazur, G. Slaney

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL | |
| General Condition of Concrete | Sluiceway, which is only way of outletting water other than the spillway consists of hand-removable wooden stop logs. Stop logs and concrete in good condition. |
| Rust or Staining | |
| Spalling | |
| Erosion or Cavitation | |
| Visible Reinforcing | |
| Any Seepage or Efflorescence | None. |
| Condition at Joints | Good. |
| Drain Holes | No drain holes were found. |
| Channel | Good condition. |
| Loose Rock or Trees Overhanging Channel | Insignificant regarding present safety. |
| Condition of Discharge Channel | Good. |
| | Note: Outlet channel and discharge channel for spillway are one in the same. |

PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Spillway/Channel

NAME T. O. Keller, D. P. LaGatta

DISCIPLINE Structural/Hydraulic/Geotechnial Engineers

NAME S. Mazur, G. Slaney

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS | |
| a. Approach Channel | No approach channel. |
| General Condition | |
| Loose Rock Overhanding Channel | |
| Trees Overhanging Channel | |
| Floor of Approach Channel | |
| b. Weir and Training Walls | |
| General Condition of Concrete | Good. |
| Rust or Staining | None observed. |
| Spalling | None observed. |
| Any Visible Reinforcing | None observed. |
| Any Seepage or Efflorescence | None observed. |
| Drain Holes | None observed. |
| c. Discharge Channel | Same as channel for outlet works. |
| General Channel | Good condition. |
| Loose Rock Overhanging Channel | None. |
| Trees Overhanging Channel | Insignificant regarding present safety. |
| Floor of Channel | Boulders protect channel floor - appear stable. |
| Other Obstructions | None observed. |

# PERIODIC INSPECTION CHECK LIST

PROJECT Crystal Lake - Gilmington

DATE September 13, 1978

PROJECT FEATURE Service Bridge

NAME

DISCIPLINE Structural Engineer

NAME S. Mazur

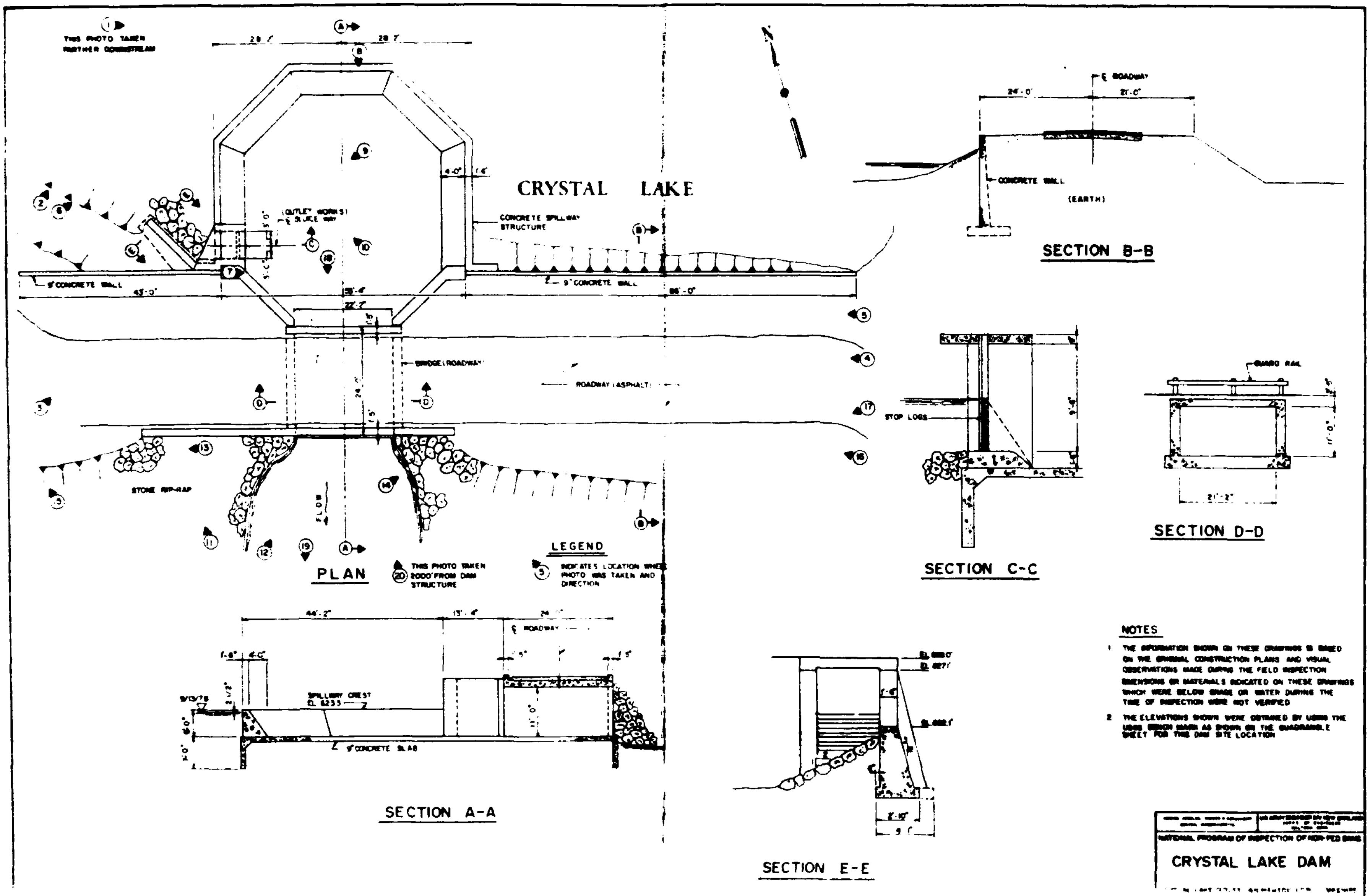
| AREA EVALUATED | CONDITION |
|---|---|
| <u>OUTLET WORKS - SERVICE BRIDGE</u> | |
| a. Super Structure | This facility has no Service Bridge. |
| Bearings | |
| Anchor Bolts | |
| Bridge Seat | |
| Longitudinal Members | |
| Under Side of Deck | |
| Secondary Bracing | |
| Deck | |
| Drainage System | |
| Railings | |
| Expansion Joints | |
| Paint | |
| b. Abutment & Piers | |
| General Condition of Concrete | |
| Alignment of Abutment | |
| Approach to Bridge | |
| Condition of Seat & Backwall | |

## APPENDIX B

1. LIST OF DESIGN, CONSTRUCTION AND MAINTENANCE RECORDS
2. PAST INSPECTION REPORTS
3. PLANS AND DETAILS

## AVAILABLE ENGINEERING DATA

A set of drawings dated 1958 showing additions and improvements made to the existing dam as well as some earlier design sketch plans are available at the State of New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301.


THIS PHOTO TAKEN FARTHER DOWNSTREAM
CRYSTAL LAKE
(OUTLET WORKS)
℄ SLUICE WAY
CONCRETE SPILLWAY STRUCTURE
9" CONCRETE WALL
BRIDGE (ROADWAY)
ROADWAY (ASPHALT)
STONE RIP-RAP
FLOW
PLAN
LEGEND
THIS PHOTO TAKEN 2000' FROM DAM STRUCTURE
INDICATES LOCATION WHERE PHOTO WAS TAKEN AND DIRECTION
℄ ROADWAY
CONCRETE WALL
(EARTH)
SECTION B-B
STOP LOGS
SECTION C-C
GUARD RAIL
SECTION D-D
SPILLWAY CREST EL 6233
9" CONCRETE SLAB
SECTION A-A
SECTION E-E
NOTES
1. THE INFORMATION SHOWN ON THESE DRAWINGS IS BASED ON THE ORIGINAL CONSTRUCTION PLANS AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.
2. THE ELEVATIONS SHOWN WERE OBTAINED BY USING THE USGS BENCH MARK AS SHOWN ON THE QUADRANGLE SHEET FOR THIS DAM SITE LOCATION.
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
CRYSTAL LAKE DAM

# PAST INSPECTION REPORTS

March 4, 1953

CRYSTAL LAKE - 91.11

At the request of Mrs. Good who was acting as messenger for some townspeople, I have examined the conditions at Crystal Lake Dam. I have also checked on Places Pond and Suncook Pond dams.

Places Pond is full with about 4" of water going over the crest. Gates are closed. The overflow is poorly vented and there is a considerable vacuum break in the overflow sheet.

Suncook Ponds are full and there is 4" to 5" of water going over the dam. Gates are closed.

Crystal Lake is down about 6" below the top of flashboards. One gate is nearly completely open and the other gate is closed. The water has been at least 18" higher than observed within the last few weeks. The flashboards are partially failed and are braced with a 4 x 4 to hold them in place. The pipe pins are sticking up several inches over the top of the flashboards. The stem of one gate is broken but not to the extent that the gate is completely out of use. The gate supports are in need of repair or replacement. The condition of the flashboard sills could not be determined.

The Crystal Lake dam is in such a condition that it needs extensive repairs and until such time as these repairs are made the operation of the dam is critical.

Mr. Mitchel, a Selectman, has been acting as agent for Textron, Inc. but he feels that he is not physically capable of giving the operation the attention and effort necessary for safe operation. Considering the condition of the dam and the need for careful and continuous attention until repaired, it appears necessary that someone else should be selected to be responsible for the operation.

Mr. Haskell, a resident on the lake shore, has experienced damage several times due to high water conditions. Some damage has been done recently by ice while the lake was at a high stage. Mr. Haskall is seriously concerned with his legal rights with regard to reimbursement for damages. I have no opinion on this matter.

Discussion with Mr. Mitchel indicated that one more flashboard could be removed and thus help to furnish a more desirable lake level with less operation of the gates. This should not be done permanently without redesigning the flashboard pins. It should not be done unless preceded by some sort of a survey to determine the attitude of the lake shore people on the desirable lake level. The owners of the dam will also have an opinion on the desirability of removing another flashboard.

Another condition that needs attention is the coordination of the operation of Places Pond with that of Crystal Lake. Evidently, in the past, the Places Pond gates have been opened without notification to the operator at Crystal Lake with the result that the lake level

rises considerably before the operator is aware of the increased inflow. Some arrangements should be made for this coordination of operation. The same coordination would not normally be necessary with respect to Suncook Ponds unless the change in gate opening at Crystal Lake was great and during high runoff conditions.

Leonard R. Frost
Water Resources Engineer

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Gilmanton DAM NO. 91.11 STREAM Suncook River

OWNER Geo. H. Jones ADDRESS Rochester, N.H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 6/4/51 ~~accompanied by~~

NOTES ON PHYSICAL CONDITION

Abutments Excellent

Spillway Good

Gates Operable

Other

CHANGES SINCE LAST INSPECTION

FUTURE INSPECTIONS Yes.

This dam (is) ~~(is not)~~ a menace because of possible damage to highway bridge.

REMARKS Gage Reading — 8.02

Conservation Storage & Regulation

| Copy to Owner | Date |
|---|---|
| | |
| | |
| | |

INSPECTOR

(Additional Notes Over)

Rec'd 10/24/38

| | |
|---|---|
| Jacobson | |
| Holmgren | ✓ |
| Calvin | |
| | |
| | |
| Return to | |
| Filed | |
| File No. | |

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire
October 17, 1938.

91.11

Pittsfield Mills,
Pittsfield N H

RE: Crystal Lake Dam. W. C. C. No. 91.11

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No
2. If so, to what extent? Ans. —
3. Did all flashboards go out? Ans. No
4. What was the maximum height of water over the permanent crest of spillway? Ans. 4" above crest.
5. At what day and hour did the maximum flood height reach your dam? Ans. Sept 27. to Sept 27. no change
6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

By [illegible]

CDC:GMB
Enc.

APPENDIX C

PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE 1
LOCATED IN APPENDIX B

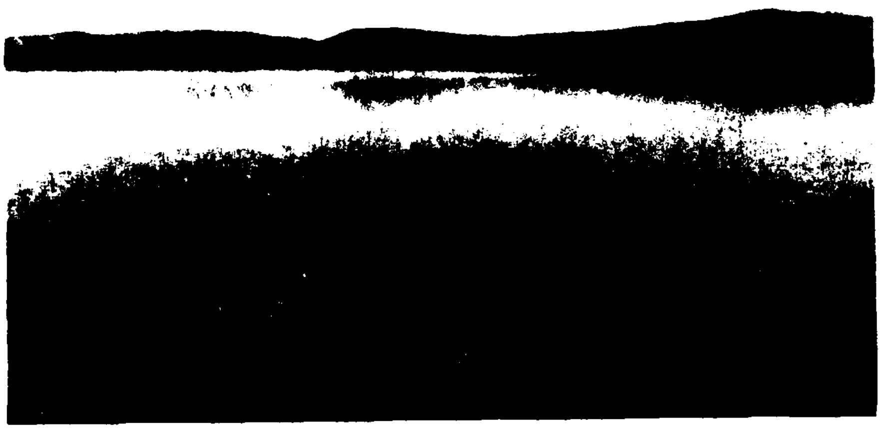


PHOTO NO. 1 - General view of reservoir from right side of Lake.

PHOTO NO. 2 - General view of reservoir from roadway dam area.

PHOTO NO. 3 - General view of dam from right abutment.

PHOTO NO. 4 - General view of dam from left abutment.

PHOTO NO. 5 - View of upstream slope and structures from left abutment.

PHOTO NO. 6 - View of upstream slope and spillway structure from right abutment.

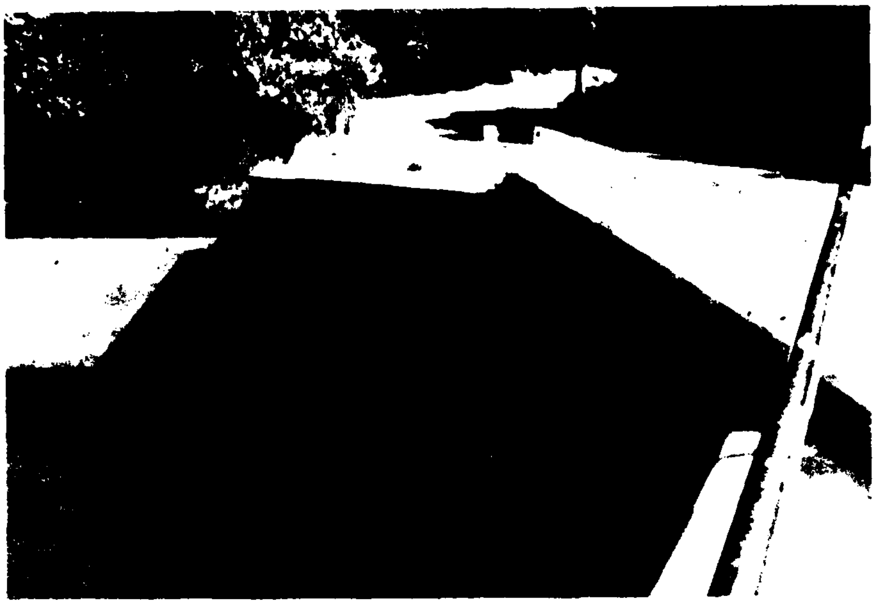


PHOTO NO. 7 - View of upstream slope from right side of dam.

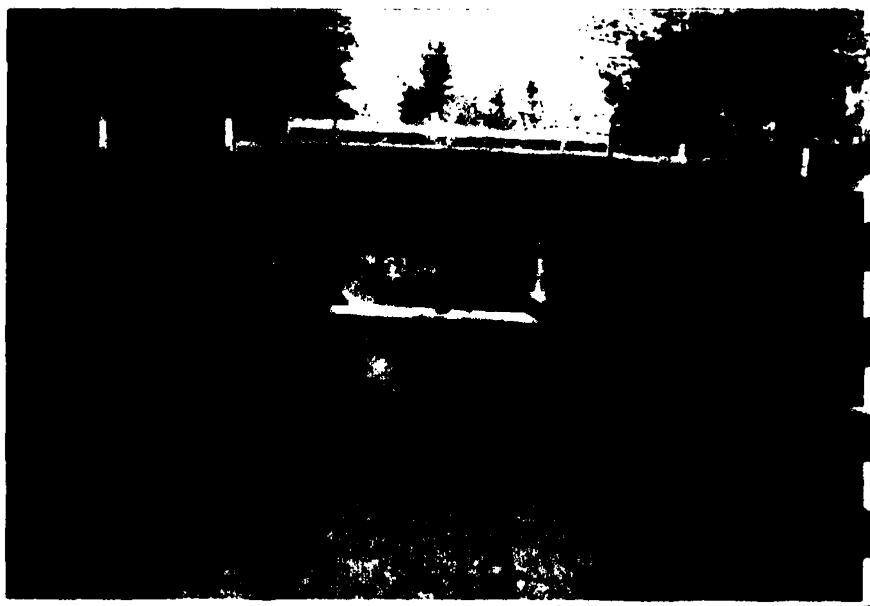


PHOTO NO. 8 - View of roadway bridge, dam and discharge channel from spillway slab

PHOTO NO. 9 - View of upstream slope, right side and sluiceway structure.

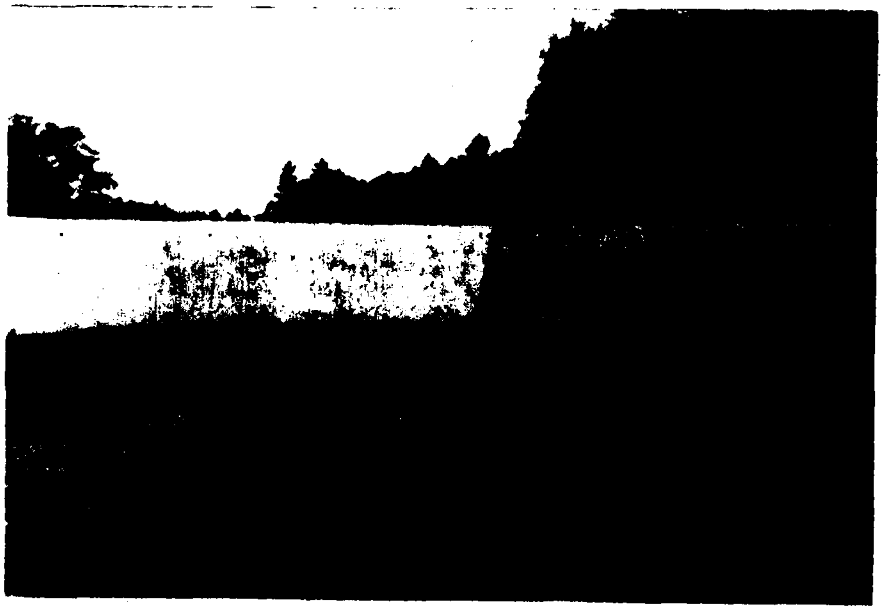


PHOTO NO. 10 - Close-up view of spillway structure.

PHOTO NO. 11 - Right retaining wall, roadway bridge, view from downstream channel.

PHOTO NO. 12 - Left retaining wall, roadway bridge, view from downstream channel.

PHOTO NO. 13 - View of spring emanating from beneath stone wall next to right roadway bridge retaining wall.

PHOTO NO. 14 - View of spring emanating from riprap on downstream slope next to left culvert retaining wall.

PHOTO NO. 15 - View of downstream slope of embankment on the right side of the concrete highway bridge showing stone wall. Photo taken from right abutment.

PHOTO NO. 16 - View of downstream slope of embankment on the left side of the highway bridge. Photo taken from left abutment area.

PHOTO NO. 17 - View of downstream slope in Photo 16 taken from embankment crest.

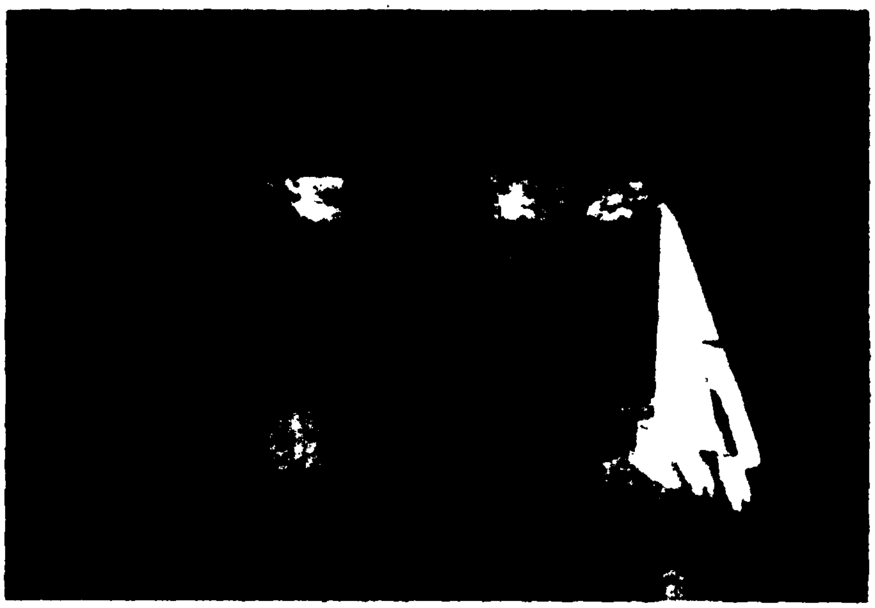


PHOTO NO. 18 - View of spillway channel and downstream channel.

PHOTO NO. 19 - View of discharge channel, 200 feet
from dam structure (looking downstream).

PHOTO NO. 20 - View of river channel, 2,000 feet
from dam structure (looking upstrear .

# APPENDIX D

# HYDROLOGIC AND HYDRAULIC COMPUTATIONS

HNTB
HOWARD NEEDLES TAMMEN & BERGENDOFF

| Made by H.M. | Date 10 7 78 | Job No. 3528-11-05 |
|---|---|---|
| Checked by [illegible] | Date 11/10/78 | Sheet No. 1 |

For CRYSTAL LAKE DAM - GILMANTON

# BASIC DATA:

DRAINAGE AREA: 27.4 Square Miles (checks w/ NHWRB data)
DAM CLASSIFICATION (BASED ON CORPS OF ENGINEERS GUIDELINES)
SIZE: INTERMEDIATE (Storage = 2,500 AF > 1000 AF)
HAZARD POTENTIAL: SIGNIFICANT

## SPILLWAY DATA

Permanent Spillway Length = 115.5'
Elevation - Permanent Crest = 623.3' M.S.L.
Type: Concrete wall, gravity, U-Shaped
Top width = 18"

## DAM DATA

Length of Crest = 138 Feet ±
Elevation - Top of Crest = 629' ± M.S.L.
Type: Roadway embankment with a Bridge opening of 21.2'-wide and 11' high

## SPILLWAY CAPACITY DETERMINATION

To determine the spillway capacity it is assumed that the bridge opening is a hydraulic control which produces a tailwater condition, thus submerging the spillway crest for large flows.

It is also assumed that there are no more hydraulic control downstream, that could affect the first assumption.

A stage - discharge curve was prepared for the Bridge opening acting under inlet control and going thru critical depth at the inlet.

ME101-374-20M

| HNTB<br>HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 10/18/78 | Job No. 5629-11-05 |
|---|---|---|---|
| | Checked by MWB | Date 11/13/78 | Sheet No. 2 |
| For CRYSTAL LAKE DAM - GILMANTON. | | | |

BRIDGE DATA.

OPENING SIZE : 21.2-ft wide and 11.0' high. ✓
TYPE : Rectangular w/ wingwalls. ✓
Assume no entrance losses. and the flow goes through critical depth at the entrance. (Inlet control) ✓

FORMULA: (For rectangular Channel)

$Q = B\,y_c\sqrt{g\,y_c}$ ✓

$H_B = 3/2\ y_c$ ✓

where:
Q = Discharge
B = width (21.2')
$y_c$ = depth of water (critic)
$H_B$ = Headwater. Upstream Bridge.

Prepare a Stage-Discharge rating curve for The Bridge opening. (See Fig. 1) with the data computed below:

$$Q = f(H) = B\ \frac{2}{3}H_B \times \sqrt{g} \times \left[\frac{2}{3}H_B\right]^{1/2}$$ ✓

$$= 21.2 \times \left(\frac{2}{3}\right)^{1.5} H_B^{3/2} \times \sqrt{32.2} = 65.3\ H_B^{3/2}$$

For $H_B < 16.5'$ ✓

TABLE 1

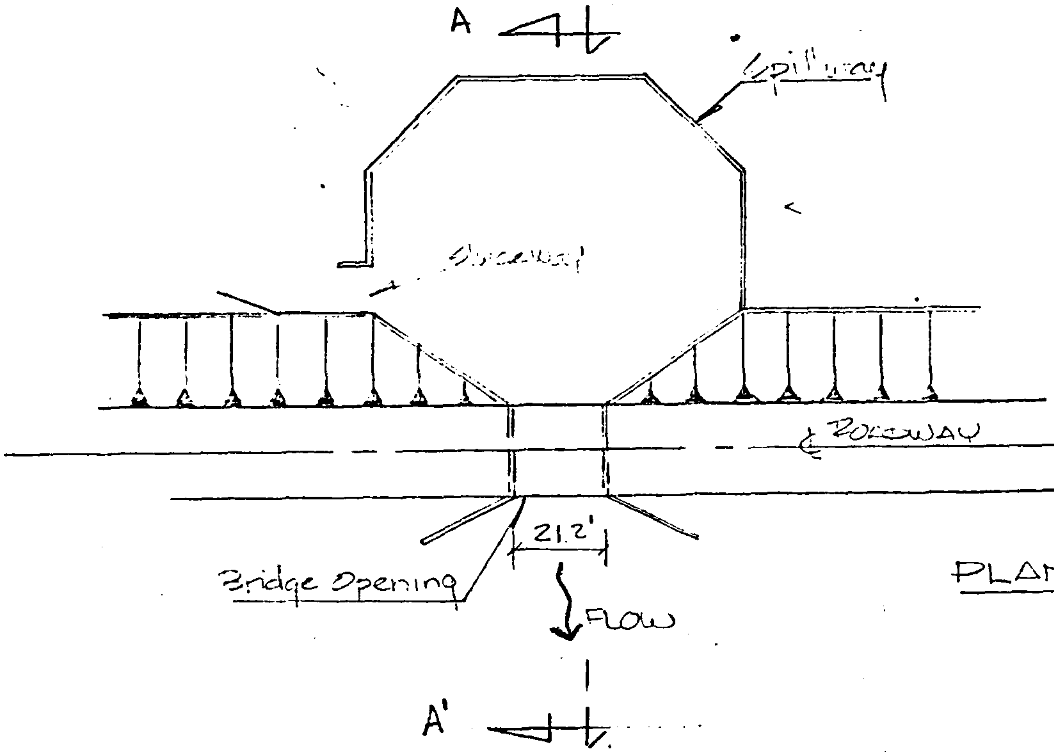
| ELV. MSL | $H_B$ (FT) | Q (CFS) | $H_2$ (Head above spillway) | REMARKS |
|---|---|---|---|---|
| 619 | 2 | 184 ✓ | (Spillway crest El. 623.3) 0 | Unsubmerged |
| 621 | 4 | 522 ✓ | 0 | " |
| 623 | 6 | [illegible]60 | 0 | " |
| 625 | 8 | 1473 | 1.7 | Submerged |
| 627 | 10 | 2065 ✓ | 3.7 | " |
| 629 | 12 | 27[illegible] * | 5.7 | " |
| 631 | 14 | 3420 ✓ | 7.7 | " |
| 633 | 16 | 4,179 | 9.7 | " |
| 633.5 | 16.5 | 4,377 ✓ | 10.2 | " |

* elev. 629 ± = dam crest elevation. Above 629 ± flow begins over crest.

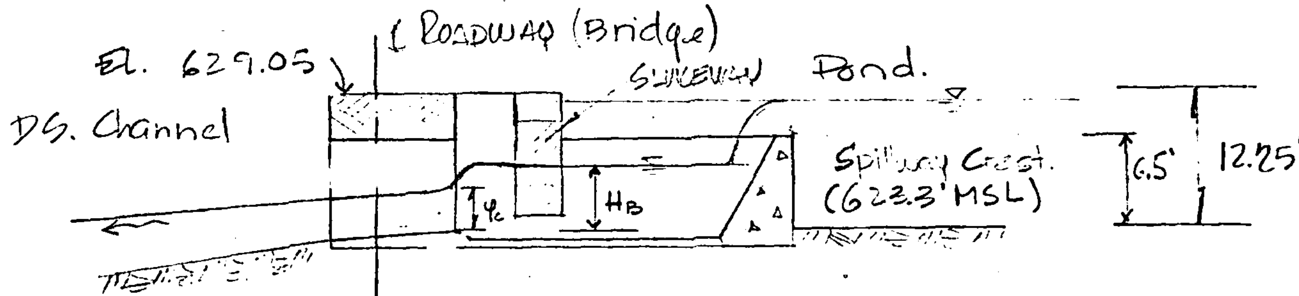
ME101-3/4-20M

| HNTB<br>HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 10/17/78 | Job No. 5493-11-05 |
|---|---|---|---|
| | Checked by [illegible] | Date 11/10/78 | Sheet No. 3 |

For CRYSTAL LAKE GILMANTON




PLAN VIEW




Section A - A'

From Section AA it can be obserbed the $H_B$ will control the spillway capacity when $H_B$ becomes larger than 6.5' or the spillway height. (See also - Table 1)
Because of the U-shape spillway the effective length will be assumed as 93.4 feet (as scaled along toe of spillway, not height)

Prepare a stage-discharge rating curve for the spillway up to elevation 629.05' MSL. Above this elevation the total discharge from the pond is the addition of the

ME101-374-20M

two discharges, the flow through the bridge opening and the flow going over the crest. (or the roadway embankment) of dam.

For flows over 1000 CFS±, the spillway becomes completely submerged and the water surface inside the U-Shaped spillway will reach [illegible] the same elevation as the lake. Therefore, the headwater above the bridge opening will be the same for both the roadway and the opening, and, with no further control by the spillway.

For Stage-Discharge curve see Fig. No 2 and for the corresponding values see Table 2.

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGE.

STEP 1: Determine Peak Inflow ($Q_{P_1}$) from guide curves.

This dam is classified as of Intermediate Size and High Hazard Potential. The Corps OF Engineers guidelines suggest to use the $\frac{1}{2}$ PMF as the test flood.

DATA
Drainage Area: 27.4 S.M.
Basin Characteristics: Rolling Zone
Test Flood = PMF

From Guide Curve for Rolling Terrain & D.A = 27.4 S.Miles the rate for PMF = 1,350 CFS/S.M.; use half the rate!

$$\text{Then } Q_{P_1} = \left[ D.A \times \frac{RATE}{2} \right]$$

$$= 27.4 \text{ SM} \times 675 \text{ CFS/SM} = 18,495 \text{ CFS}$$

$$\text{Say } Q_{P_1} = 18,500 \text{ CFS}$$

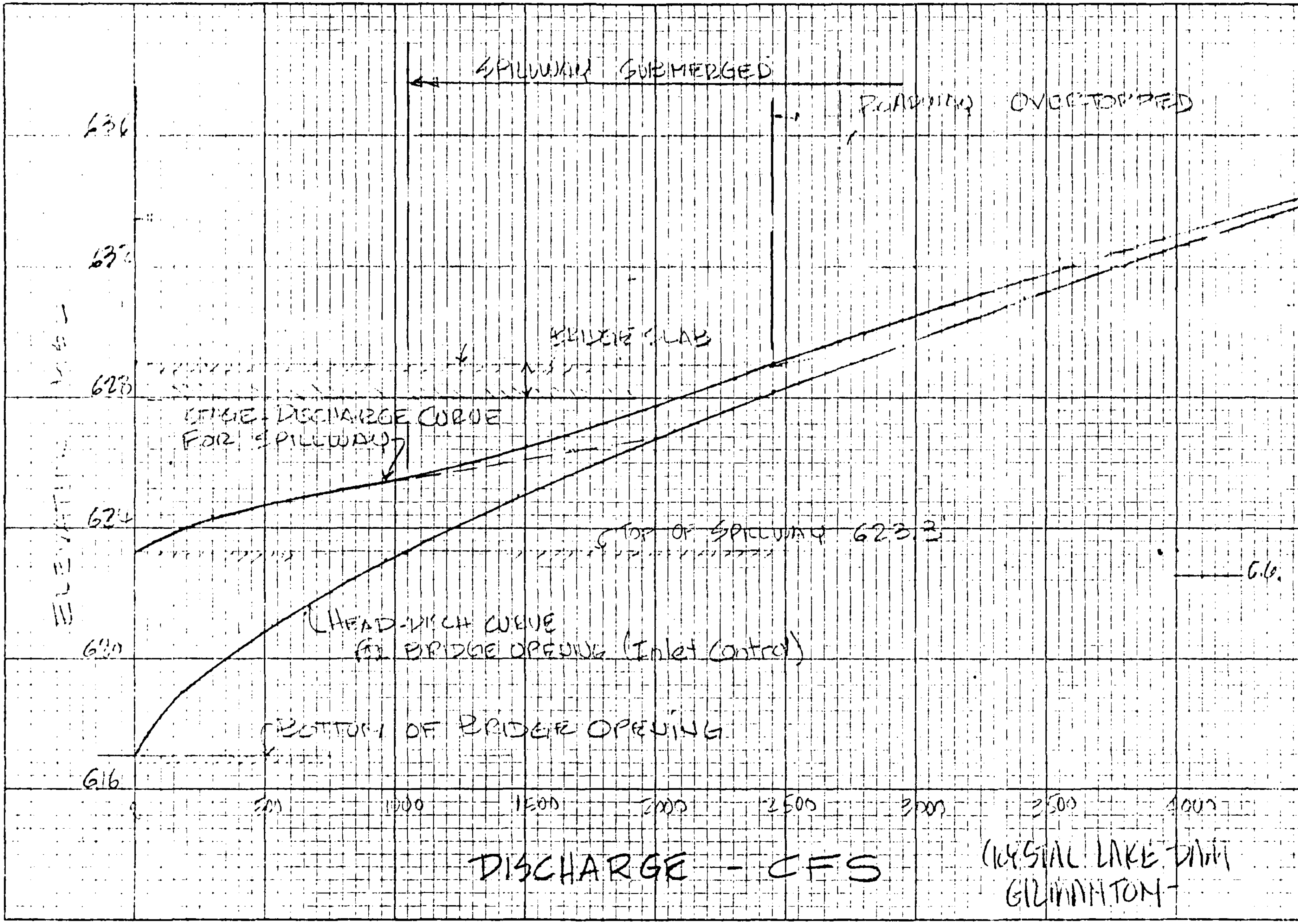



FIG No. 1

FIG No. 1

| HNTB | Made by HM | Date 11/01/78 | Job No. 5623-11-05 |
|---|---|---|---|
| HOWARD NEEDLES TAMMEN & BERGENDOFF | Checked by [illegible] | Date 11/10/78 | Sheet No. 5 |
| For CRYSTAL LAKE - GILMANTON | | | |

EFFECT OF SURCHARGE STORAGE:

STEP 2. To determine the surcharge height to pass $Q_p$ = 18,500 CFS it is necessary to prepare the rating curve including the two flows one thru the bridge and other one over the crest.

For flow over the crest the following formula is used:

1. $Q_c = C \times L_c \times H_c^{3/2}$

Where.
$C$ = Broad-Crested Coeff. = 3.09
$L_c$ = Length of crest.
$H_c$ = Crest over the crest.
$Q_c$ = Flow over crest.

For flow thru the Bridge two formulas are used:

1. For values of $H < 1.2$ Depth of culvert.

$Q$ = Width $\times \varphi_c \times \sqrt{g \varphi_c}$ (1)

$H = \frac{2}{3} \varphi_c$ (2)

Where:
$\varphi_c$ = Critical Depth
$H$ = Headwater (FT)

Expressing Q as function of H, The second formula (2) is replaced in (1).

$\therefore Q = \text{Width} \times \left[\frac{2}{3} H\right] \times \left[g \frac{2}{3} H\right]^{-1/2}$.

2. For values of $H > 1.2$ depth of culvert and assuming Inlet Control the following formula was applied

$Q = C_c \times A \times \sqrt{2gh}$

Where:
$C_c$ : Contraction Coeff. .75
$A$ = Area
$h$ = Distance from c.g. of the area to W.S. Elev.

| HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 10/31/78 | Job No 828-11-05 |
|---|---|---|---|
| | Checked by DWB | Date 11/10/78 | Sheet No. 6 |
| For CRYSTAL LAKE - GILMANTON | | | |

## EFFECT OF SURCHARGE STORAGE

Prepare a rating curve (See Fig. 1-2) from values on table 2. (Elev. of Cent. of Gravity = 622.5' MSL)

TABLE 2

| LAKE WAT. SUR. ELV. FT. | "h" head at C.G. FT | FLOW THROUGH BRIDGE CFS | HEAD OVER CREST FT | FLOW OVER CREST CFS | TOTAL FLOW CFS | REMARKS |
|---|---|---|---|---|---|---|
| 623.3 | 0.8 | ① 0 | 0 | 0 | 0 | SPILLWAY CREST |
| 624 | 1.5 | ② 200 | 0 | 0 | 200 | SPILLWAY CONT. |
| 626 | 3.5 | 1300 | 0 | 0 | 1,300 | S/WAY CONTROLS |
| 628 | 5.5 | 2100 | 0 | 0 | 2,100 | S/WAY CONTROLS |
| 630 | 7.5 | 2800 | 0.95 | 540 | 3,340 | " |
| 632 | 9.5 | 3600 | 2.95 | 2,940 | 6,540 | " |
| 634 | 11.5 | 4450 | 4.95 | 6,400 | 10,850 | " |
| 636 | 13.5 | 5,160 | 6.95 | 10,640 | 15,800 | Inlet Control |
| 638 | 15.5 | 5,530 | 8.95 | 15,550 | 21,080 | |
| 640 | 17.5 | 5,870 | 10.95 | 21,050 | 26,920 | |
| 642 | 19.5 | 6,200 | 12.95 | 27,070 | 33,270 | |
| 644 | 21.5 | 6,510 | 14.95 | 32,580 | 40,090 | |

① WATER DOES NOT GO OVER THE SPILLWAY
② SEE FIG 1

From fig. 2 determine Elev. required to pass $Q_{p_1}$ = 13,500 CFS.
El. 637.0'

A). Compute $STOR_1$ in inches of Runoff

$$STOR_1 = \frac{(637.0' - 623.3) \times 441\,Ac \times 12''/FT}{27.4\,SM \times 640\,Ac/SM} = 4.13''$$

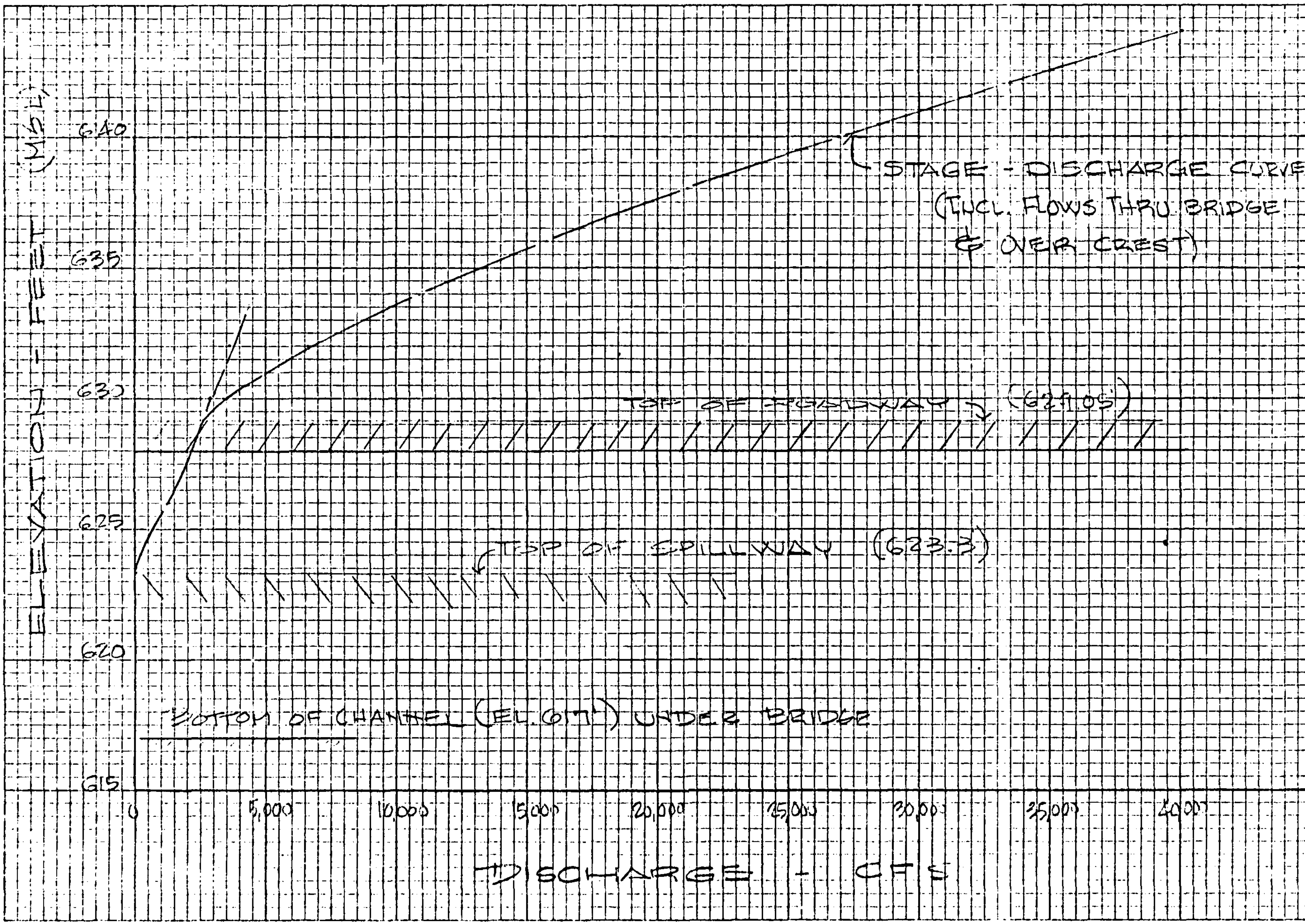

STAGE - DISCHARGE CURVE
(INCL. FLOWS THRU BRIDGE
& OVER CREST)
TOP OF ROADWAY (627.05)
TOP OF SPILLWAY (623.3)
BOTTOM OF CHANNEL (EL. 617') UNDER BRIDGE
ELEVATION - FEET (MSL)
640
635
630
625
620
615
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
DISCHARGE - CFS

FIG. No 2

| HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by H.M. | Date 11/01/78 | Job No. 5622-11-05 |
|---|---|---|---|
| | Checked by [illegible] | Date 11/10/78 | Sheet No. 7 |
| For CRYSTAL LAKE - GILMANTON. | | | |

EFFECT OF SURCHARGE STORAGE

B) Compute $Q_{P_2} = Q_{P_1} \times \left[1 - \frac{STOR_1}{9.5''}\right]$

$= 18{,}500 \text{ CFS} \times \left[1 - \frac{4.13''}{9.5}\right] = 10{,}450$

$= 10{,}450$ CFS.

STEP 3: A) Determine Surcharge to pass $Q_{P_2} = 10{,}450$ CFS
EL. = 633.5' (From Fig. 2)

B) $STOR_2 = \frac{(633.5' - 623.3') \times 441 \text{ Ac} \times 12''/\text{FT}}{27.4 \text{ SM} \times 640 \text{ Ac/SM}} = 3.08''$

C) $STOR_{Avg} = \frac{4.13'' + 3.08''}{2} = 3.61''$

D) Compute $Q_{P_3} = 18{,}500 \text{ CFS} \times \left(1 - \frac{3.61''}{9.5''}\right) =$

$= 11{,}470$ CFS

STEP 4: A.) Determine Surcharge to pass $Q_{P_3} = 11{,}470$ CFS
EL. 634.25'

B) $STOR_3 = \frac{(634.25' - 623.3) \times 441 \text{ Ac} \times 12''/\text{FT}}{27.4 \text{ SM} \times 640 \text{ Ac/SM}} = 3.30''$

C) $STOR_{Avg} = \frac{3.61'' + 3.30''}{2} = 3.45''$

D) $Q_{P_4} = 18{,}500 \text{ CFS} \times \left[1 - \frac{3.45''}{9.5''}\right] = 11{,}770$ CFS

| HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 11/01/78 | Job No 5628-11-05 |
|---|---|---|---|
| | Checked by DWB | Date 11/10/78 | Sheet No. 8 |
| For CRYSTAL LAKE - GILMANTON. | | | |

EFFECT OF SURCHARGE STORAGE

STEP 5 A. Determine Surcharge to pass $Q_{P_4} = 11,770$ CFS
EL 634.30

B. $STOR_4 = \frac{(634.3' - 623.3') \times 441^{Ac} \times 12''/FT}{27.4 SM \times 640 Ac/SM} = 3.32''$

C. $STOR_{Avg} = \frac{3.45'' + 3.32''}{2} = \underline{3.38''}$

D. $Q_{P_5} = 18{,}000 \text{ CFS} \times \left[1 - \frac{3.38''}{9.5''}\right] = 11{,}910$ CFS

EL. 634.30' required to pass 11,910 cfs

$STOR = \frac{(634.3' - 623.3') \times 441^{Ac} \times 12''/FT}{27.4 SM \times 640 Ac/SM} = 3.33''$ OK

$Q_{P_5} = 11{,}910$ CFS

CONCLUSIONS :

1. The test flood discharge ($Q_{P_5} = 11{,}910$ CFS) will overtop the crest of dam by about 5.2 feet.

2. The spillway capacity with Backwater from Bridge opening control without overtopping the dam is about 2450 CFS which is approx. the. 20.6% of the test flood discharge.

| HNTB | Made by HM | Date 10/19/78 | Job No 5333-11-05 |
|---|---|---|---|
| HOWARD NEEDLES TAMMEN & BERGENDOFF | Checked by [illegible] | Date 11/10/78 | Sheet No. 9 |

For CRYSTAL LAKE DAM - GILMANTON

ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS:

METHOD: "Rule of Thumb" is used to analyze these effects:

STEP 1: Determine or estimate the Reservoir Storage (S) in Acre-Feet at time of failure:

Max. Storage at Elev. 629.05' MSL = 3,500 A-F

Then: $S = 3{,}500$ A-F

STEP 2: Determine Peak Failure Outflow ($Q_{p_1}$)

$$Q_{p_1} = \frac{8}{27} \times \sqrt{g} \times W_b \, Y_o^{3/2}$$

$W_b$ = Breach width (Use 40% of total length)
= 0.40 × 188' =

$Y_o$ = Total Height = 12.25'

Then:

$$Q_{p_1} = 1.68 \times 75.2' \times (12.25)^{3/2} = 5{,}416 \text{ CFS}$$

SAY $Q_{p_1} = 5{,}400$ CFS.

STEP 3: Prepare Stage-Discharge curve for selected section using USGS map.

REACH 1 (Approx. Loc. Sta. 16+00±)
$Q_{p_1}$ = 5,400 CFS

REACH DATA
L = 3,800'
$S_o$ = 0.0039%
n = 0.06

CHANNEL DATA
SHAPE = Trapezoidal
BANK SLOPE = 5:1 (Both sides)
WIDTH (BASE) = 400'

| HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 10/20/78 | Job No. 5628-11-05 |
|---|---|---|---|
| | Checked by [illegible] | Date 11/15/78 | Sheet No. 10 |

For CRYSTAL LAKE DAM - GILMANTON

ESTIMATING DOWNSTREAM EFFECTS (cont.) (Reach 1)
(Reach 1, cont.)

STEP 4 Determine the stage for $(Q_{P_1}) = 5{,}400$ CFS
From fig. No 3:

A) Stage = 3.7' Area = 1548 ✓

$$\text{Volume } V_1 = \frac{1548^{\#} \times 3{,}800'}{43560\,CF/AF} = 135\text{ A-F} < S/2 \text{ OK}$$

B) Compute $Q_{P_2(Trial)} = Q_{P_1} \times \left[1 - \frac{V_1}{S}\right] =$

$$= 5{,}400^{CFS} \times \left[1 - \frac{135\text{ AF}}{3500\text{ AF}}\right] = 5192^{CFS}$$

$$Q_{P_2} = 5{,}192\text{ CFS}$$

c) From Fig. 3 determine the stage for $Q_{P_2} = 5{,}192$ CFS

Stage = 3.61' ± Area = 1,509

$$V_2 \doteq \frac{1509^{\#} \times 3{,}800}{43{,}560\text{ CF/AF}} = 132\text{ AF}$$

D) Compute $V_{avg}$

$$V_{avg} = \frac{V_1 + V_2}{2} = \frac{(135 + 132)}{2}\text{AF} = 133.5\text{AF}$$

$$\text{Then } Q_{P_2} = 5400 \times \left[1 - \frac{133.5\text{AF}}{3500\text{AF}}\right]\text{CFS} = 5{,}194\text{ CFS.}$$

## REACH No 2

REACH DATA
Length = 3,200'
Slope = 0.0125%
Manning's n = 0.08

CHANNEL DATA
Shape = Trapezoidal.
Bank Slopes = 3.6:1 (Both sides)
Base width = 190'

| HNTB | Made by HM | Date 10/20/78 | Job No 5623-11-05 |
|---|---|---|---|
| HOWARD NEEDLES TAMMEN & BERGENDOFF | Checked by VWB | Date 11/15/78 | Sheet No. 11 |

For CRYSTAL LAKE DAM - GILMANTON

## ESTIMATING DOWNSTREAM EFFECTS (cont.)

STEP 4. For Stage-Discharge curve see FIG No 3
Determine the stage for $Q_{P_1} = 5{,}194$ CFS:

A) Stage = 4.61'± for $Q_{P_1} = 5{,}194$ CFS
AREA = 952#

$$\text{Volume } V_1 = \frac{3{,}200' \times 952^{\#}}{43{,}560 \text{ CF/AF}} = 70 \text{ AF}$$

B)
$$\text{Compute } Q_{P_2(\text{Trial})} = 5{,}194^{\text{CFS}} \times \left[1 - \frac{70 \text{ AF}}{3500 \text{ AF}}\right] = 5{,}090 \text{ CFS}$$

c) From Fig. 3 determine the Stage for $Q_{P_2} = 5{,}090$ CFS

Stage = 4.56'   Area = 941#

$$\text{Volume } V_2 = \frac{3{,}200' \times 941^{\#}}{43{,}560 \text{ CF/AF}} = 69.14 \text{ AF.}$$

D) Average $V_1$ & $V_2$

$$V_{Avg} = \frac{70 + 69.14}{2} \text{ AF} = 69.57 \text{ A.F}$$

$$Q_{P_2} = 5{,}194 \text{ CFS} \times \left[1 - \frac{69.57 \text{ AF}}{3500 \text{ AF}}\right] = 5{,}091 \text{ CFS}$$

REACH No 3.

| REACH DATA | | CHANNEL DATA |
|---|---|---|
| LENGTH | = 5,200' | Shape = Non-symmetrical Trapezoid. |
| SLOPE | = 0.0017 | Bank Slopes: LT = 2.75:1 ; RT = 15:1 |
| MANNING'S "n" | = 0.09 | Base width = 26.5' |

| HNTB Howard Needles Tammen & Bergendoff | Made by H.M. | Date 10/20/78 | Job No. 5322-11-05 |
| --- | --- | --- | --- |
| | Checked by [illegible] | Date 11/10/78 | Sheet No. 12 |

For CRYSTAL LAKE DAM - GILMANTON

STEP 3 For Stage-discharge curve see Fig No 3

STEP 4. A) Determine the stage for $Qp_1 = 5{,}091$ CFS

Stage = 6.57' ± Area = 2124#

Volume $V_1 = \frac{5{,}200' \times 2{,}124^{\#}}{43{,}560 \text{ CF/AF}} = 253$ AF

B) Compute $Q_{P_2}(\text{Trial}) = Q_{P_1} \times \left[1 - \frac{V_1}{S}\right] =$

Then $Q_{P_2} = 5{,}091 \text{ CFS} \times \left[1 - \frac{253 \text{ AF}}{3500 \text{ AF}}\right] = 4{,}722$ CFS.

C) Determine the Stage for $Q_{P_2}$.

Stage = 6.29' Area = 2018#'

Volume $V_2 = \frac{2018^{\#} \times 5{,}200'}{43{,}560 \text{ CF/AF}} = 241$ AF

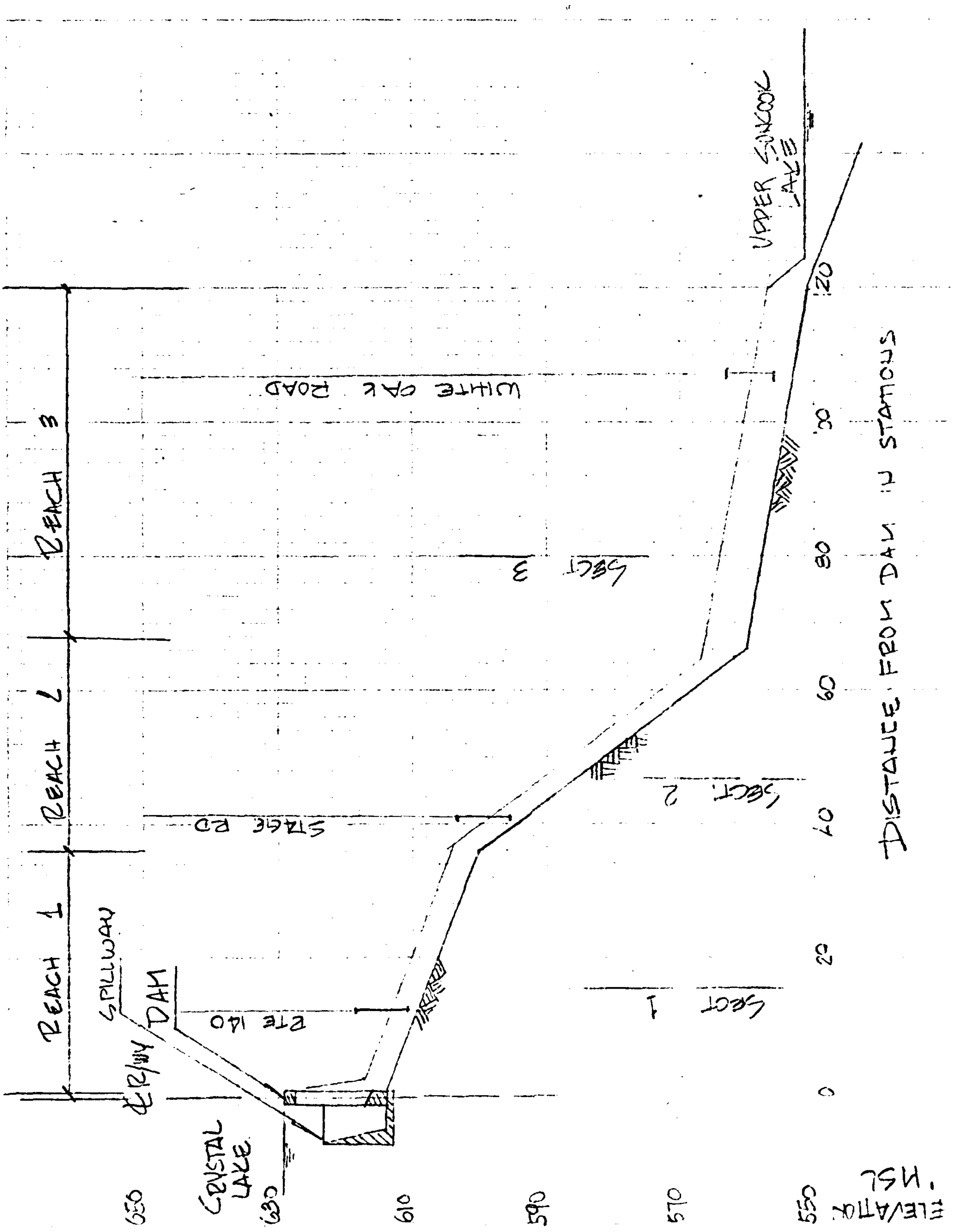
D) Compute $V_{avg} = \frac{V_1 + V_2}{2} = \frac{253 + 241}{2} \text{ AF} =$
$= 247$ AF

Final $Qp_2$:

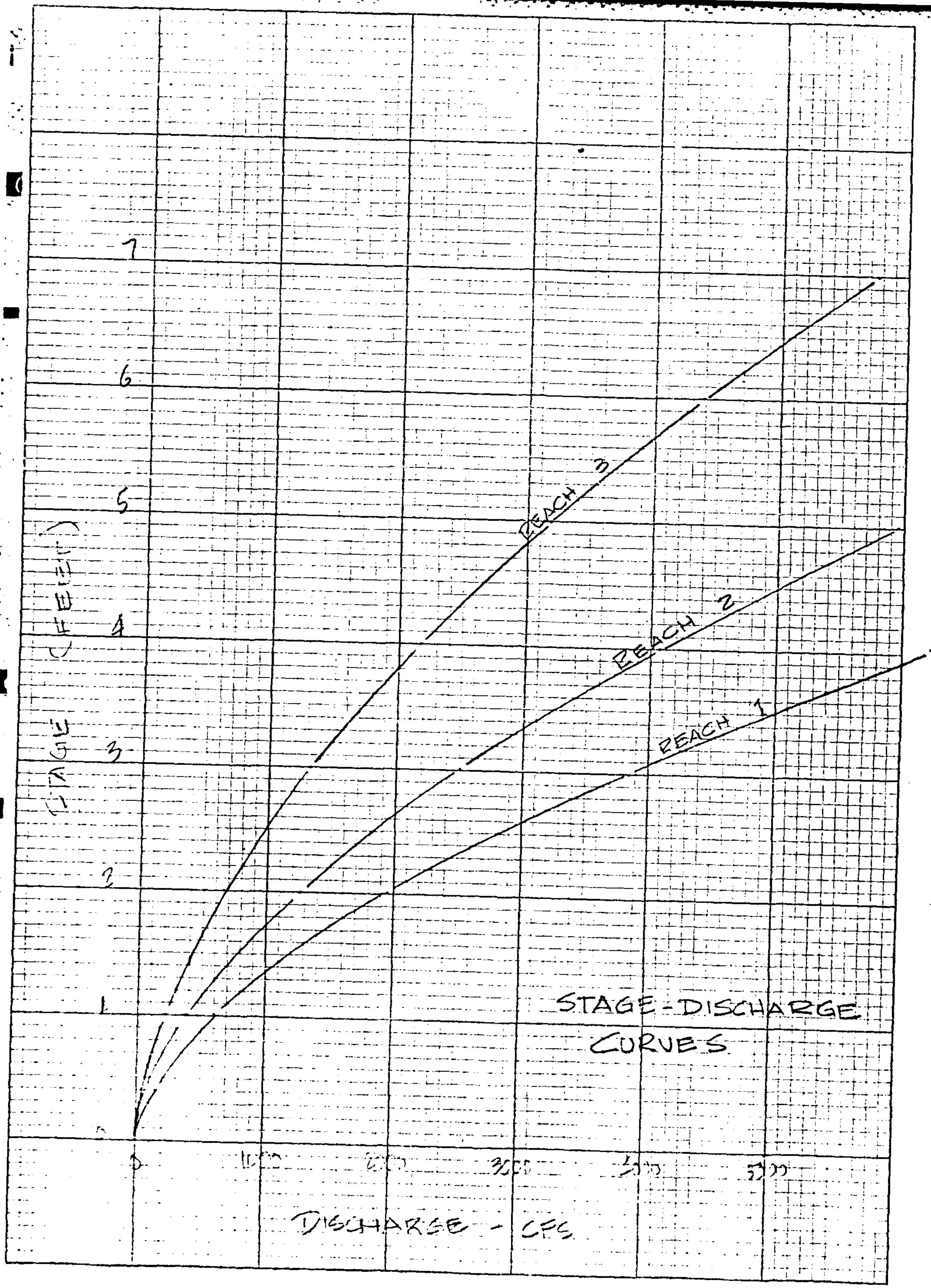
$$Qp_2 = 5{,}091 \text{ CFS} \times \left[1 - \frac{247 \text{ AF}}{3500 \text{ AF}}\right] = 4{,}732 \text{ CFS}$$

| HNTB<br>HOWARD NEEDLES TAMMEN & BERGENDOFF | Made by HM | Date 10/19/78 | Job No. 3?3-11-75 |
| --- | --- | --- | --- |
| | Checked by [illegible] | Date 11/16/78 | Sheet No. 13 |

Calculations For CRYSTAL LAKE DAM - GILMANTON

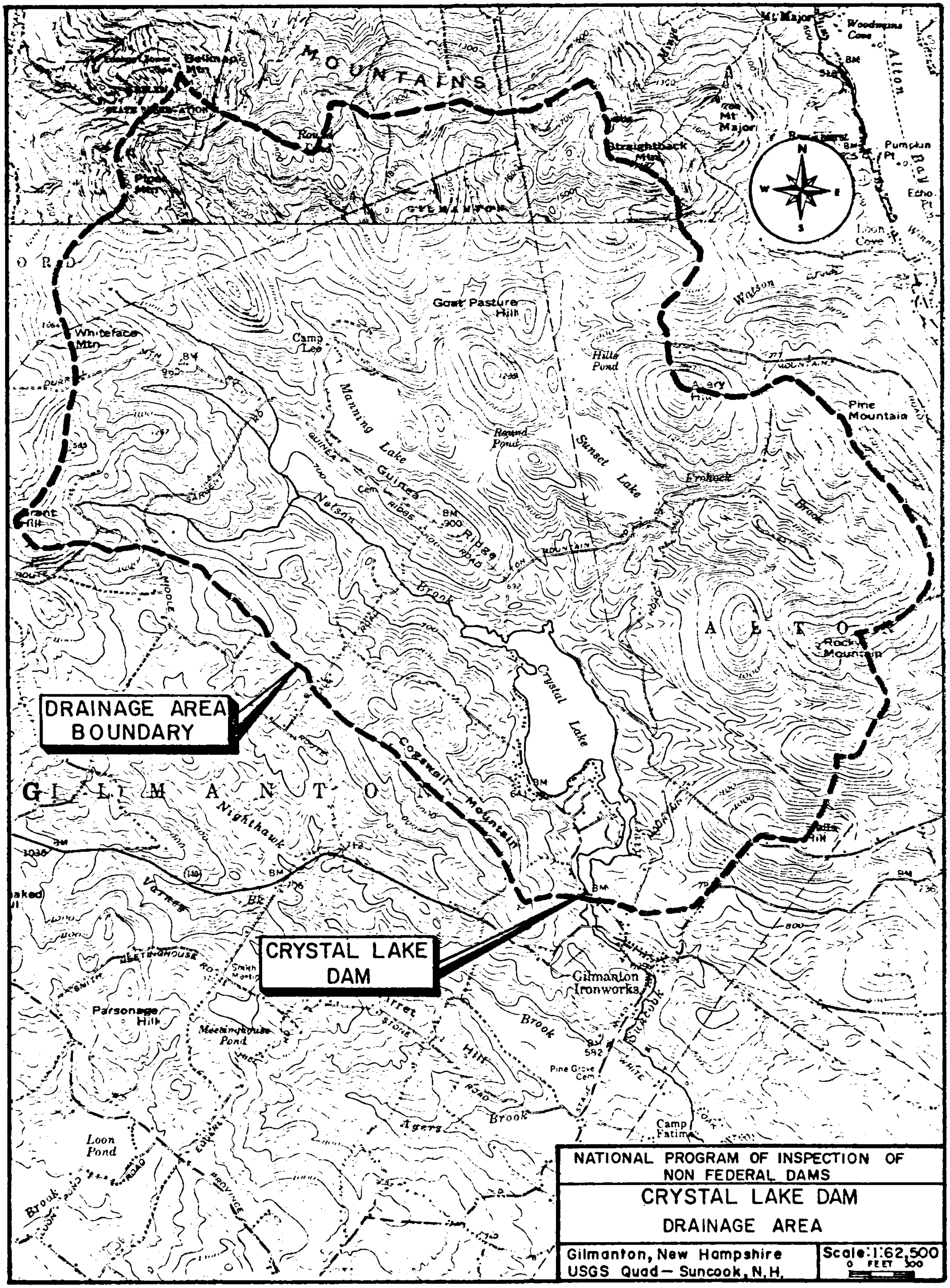



GN102-1173-12M



STAGE (FEET)
7
6
5
4
3
2
1
0
1000
2000
3000
4000
5000
DISCHARGE - CFS
REACH 3
REACH 2
REACH 1
STAGE-DISCHARGE CURVES


FIG 3



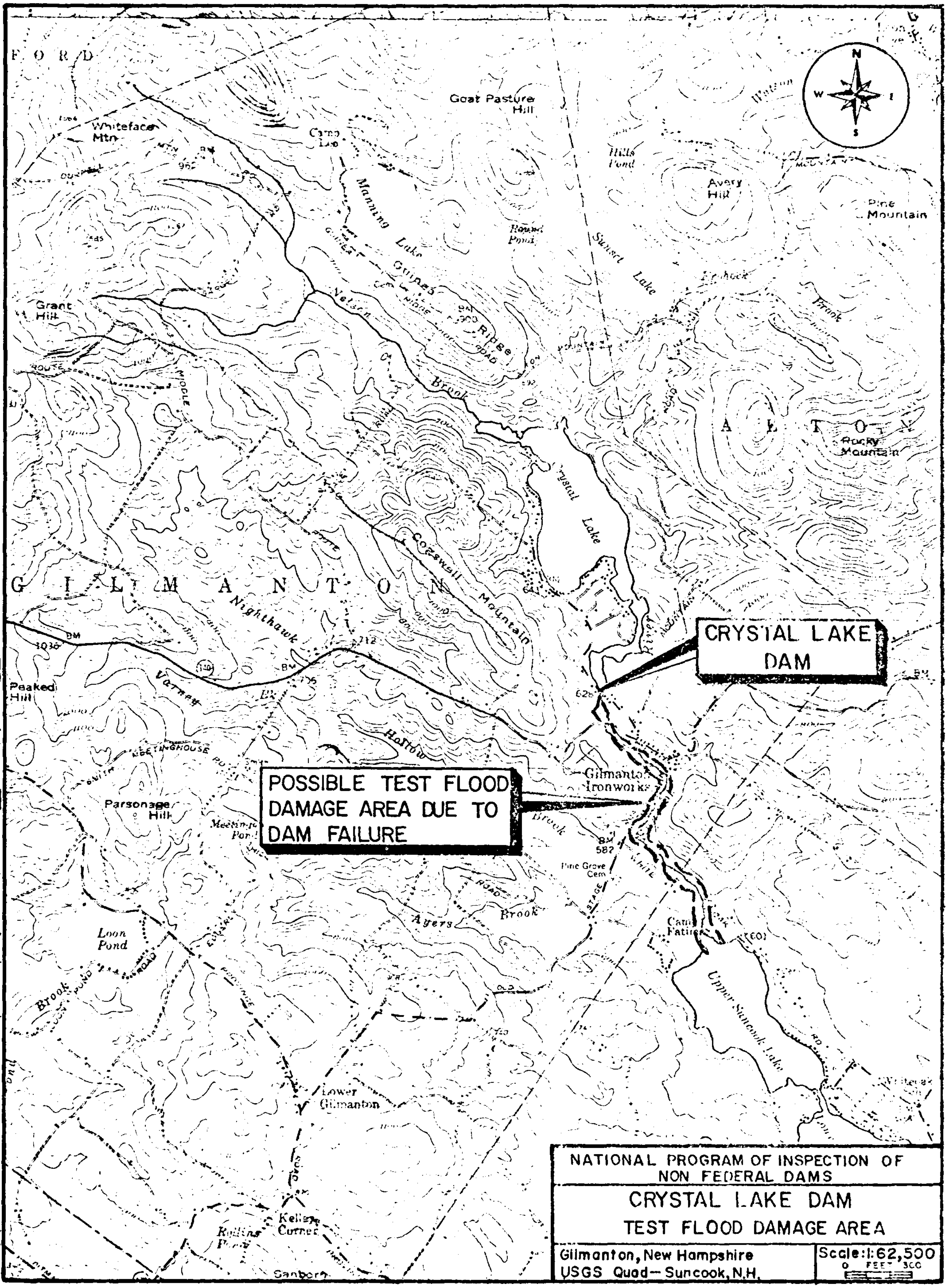

NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS

CRYSTAL LAKE DAM

DRAINAGE AREA

Gilmanton, New Hampshire
USGS Quad— Suncook, N.H.

Scale: 1:62,500



CRYSTAL LAKE DAM
POSSIBLE TEST FLOOD DAMAGE AREA DUE TO DAM FAILURE
Goat Pasture Hill
Whiteface Mtn
Grant Hill
Peaked Hill
Parsonage Hill
Loon Pond
Avery Hill
Pine Mountain
Rocky Mountain
Manning Lake
Sunset Lake
Crystal Lake
Upper Suncook Lake
Guinea Ridge
Nelson Brook
Cogswell Mountain
Nighthawk
Varney
Hollow
Ayers
Brook
G I L M A N T O N
Gilmanton Ironworks
Pine Grove Cem
Lower Gilmanton
Kelley Corner
Sanborn
NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS
CRYSTAL LAKE DAM
TEST FLOOD DAMAGE AREA
Gilmanton, New Hampshire
USGS Quad— Suncook, N.H.
Scale: 1:62,500

# APPENDIX E

## INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

# INVENTORY OF DAMS IN THE UNITED STATES

| STATE | IDENTITY NUMBER | DIVISION | STATE | COUNTY | CONGR. DIST. | STATE | COUNTY | CONGR. DIST. | NAME | LATITUDE (NORTH) | LONGITUDE (WEST) | REPORT DATE DAY MO YR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NH | 18 | NED | NH | 001 | 01 | | | | CRYSTAL LAKE-GILMANTON DAM | 4325.5 | 7118.5 | 10NOV78 |

| POPULAR NAME | NAME OF IMPOUNDMENT |
|---|---|
| CRYSTAL LAKE DAM | CRYSTAL LAKE |

| REGION | BASIN | RIVER OR STREAM | NEAREST DOWNSTREAM CITY-TOWN-VILLAGE | DIST FROM DAM (MI.) | POPULATION |
|---|---|---|---|---|---|
| 01 | 05 | SUNCOOK RIVER | GILMANTON | 1 | 1010 |

| TYPE OF DAM | YEAR COMPLETED | PURPOSES | STRUCTURAL HEIGHT (FT.) | HYDRAULIC HEIGHT (FT.) | IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.) | IMPOUNDING CAPACITIES NORMAL (ACRE-FT.) | DIST | OWN | FED R | PRV/FED | SCS A | VER/DATE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RECTPG | 1958 | RS | 16 | 12 | 3500 | 1400 | NED | N | N | N | N | 4DEC78 |

| REMARKS |
|---|
| |

| D/S HAS | SPILLWAY CREST LENGTH | SPILLWAY TYPE | SPILLWAY WIDTH (FT.) | MAXIMUM DISCHARGE (FT.) | VOLUME OF DAM (CY) | POWER CAPACITY INSTALLED (MW) | POWER CAPACITY PROPOSED (MW) | NAVIGATION LOCKS NO | LENGTH (FT.) | WIDTH (FT.) | LENGTH (FT.) | WIDTH (FT.) | LENGTH (FT.) | WIDTH (FT.) | LENGTH (FT.) | WIDTH (FT.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 188 | U | 111 | 2450 | | | | | | | | | | | | |

| OWNER | ENGINEERING BY | CONSTRUCTION BY |
|---|---|---|
| NH WATER RESOURCES BD | NH WATER RESOURCES BD | NH WATER RESOURCES BOARD |

| REGULATORY AGENCY DESIGN | CONSTRUCTION | OPERATION | MAINTENANCE |
|---|---|---|---|
| NONE | NONE | NONE | NONE |

| INSPECTION BY | INSPECTION DATE DAY MO YR | AUTHORITY FOR INSPECTION |
|---|---|---|
| HOWARD NEEDLES TAMMEN + BERGENDRF | 13SEP78 | PL 92-367 |

| REMARKS |
|---|
| |

END

FILMED

8-85

DTIC